PROCEEDINGS

Sixty-Ninth Annual Convention

OF THE

American Railway Bridge & Building Association

1964

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Proceedings of the

Sixty-Ninth Annual Convention

of the

American Railway
Bridge & Building
Association

Held at

CHICAGO, ILLINOIS

September 14-16, 1964

Published by the Association
Ruth Weggeberg, Secretary
220 So. Michigan Ave., Chicago 4

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Shirley White	Southern Pacific, San Francisco, Calif.	Second Vice-President
H. M. Wilson	Pennsylvania, Chicago	Third Vice-President
Ruth Weggeberg	220 So. Michigan Ave., Chicago	Secretary
E. F. Snyder	Illinois Central, Chicago	Treasurer

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R. C. Baker Chicago & Eastern Illinois, Chicago Heights, Ill.	President
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J. W. DeValle Southern, Atlanta, Ga.	Third Vice-President
Ruth Weggeberg 220 So. Michigan Ave., Chicago	Secretary
E. F. Snyder Illinois Central, Chicago	Treasurer

DIRECTORS

Terms Expire 1965

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J. S. Ellis, Chesapeake & Ohio	Grand Rapids, Mich.

Terms Expire 1966

J. A. Goforth, Clinchfield	Erwin, Tenn.
E. R. Simmons, Southern Pacific	San Francisco, Calif.

Terms Expire 1967

N. D. Bryant, St. Louis-San Francisco	Springfield, Mo.
A. R. Dahlberg, Western Maryland	Hagerstown, Md.

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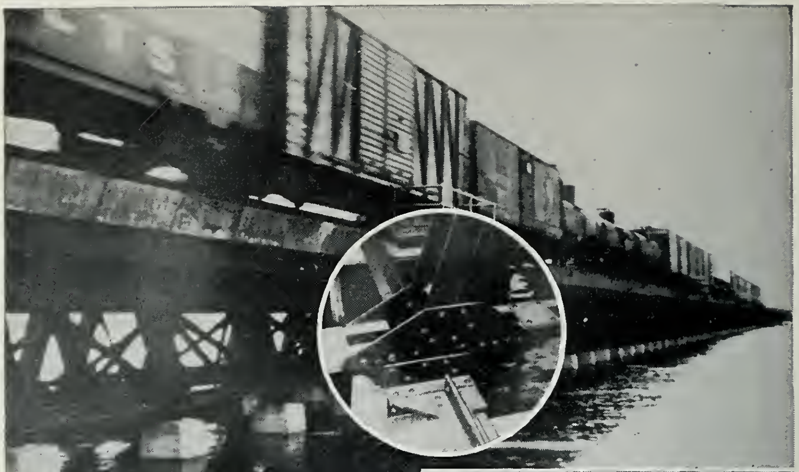

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PROCEEDINGS

The Event—The 64th Annual Convention of the Bridge and Building Association
The Date—September 14-16, 1964
The Place—Conrad Hilton Hotel, Chicago, Ill.

President E. R. Schlaf presided over separate sessions of the B&B Association.

The 69th annual convention of the American Railway Bridge and Building Association was held on September 14-16, 1964, in the Conrad Hilton Hotel, Chicago. As in past years, the convention was held in conjunction with, although separate from, the Roadmasters' and Maintenance of Way Association.

Total attendance at the conventions was 980, including 514 railroad members of the associations, 154 associate members and 312 guests. Attendance at the Bridge and Building convention totaled 332 railroad members, associate members and guests. There was no exhibit of work equipment held in conjunction with the meetings.

These proceedings give abstracts of four of the major addresses delivered during the joint sessions of the conventions and the three special features of the B&B sessions, and the reports of the five B&B special subjects committees. In addition, the proceedings include the directory of members, the constitution and by-laws of the association, and other pertinent current and historical information.

Joint Session

As usual in a non-exhibit year, two joint sessions were held during the conventions, the first on Monday morning, September 14, and the second on the following morning. The joint session on Monday was the opening meeting of the conventions and featured addresses by W. Arthur Grotz, president, Western Maryland, and J. J. Wright, director of technical research, New York Central.

Mr. Grotz's talk was entitled "Competition —Will it Make or Break You?" Mr. Wright spoke on "Research Leads by the Way."

The second joint session included addresses by A. L. Sams, chief engineer, Illinois Central, who spoke on "Let's Take a Look," and E. H. Hallmann, Chairman, Western Carriers' Conference Committee, National Railway Labor Conference, who discussed the "Methods of Obtaining the Maximum Benefits from the Settlement in the Work-Rules Case in the Use of Self-Propelled Equipment."

The concluding feature of the second joint session was an illustrated address by G. V. Guerin, chief engineer, Great Northern. Mr. Guerin described "What Record Floods Did to the Great Northern's Main Line in Montana and How It was Rebuilt."

B&B Separate Sessions

Separate sessions of the Bridge and Building convention were held on Monday and Tuesday afternoons and Wednesday morning and were presided over by President E. R. Schlaf. During these sessions the following committee reports were presented:

Modern Heating, Insulating and Ventilating Methods for Railway Buildings
Study of Most Economical Method of Renewing Bents Without Disturbance to and from Traffic
Installation and Maintenance of Tunnel Lining and Increasing Clearances in Tunnels
Latest Development in Fire Prevention Methods and Material for Bridges and Buildings and Timber-Lined Tunnels
Inspection and Maintenance of Timber Trestles for Increased Wheel Loads

The Monday afternoon separate session featured an illustrated address on "Construction Methods—Spartanburg Terminal Company Tunnel" by J. M. Salmon, Jr., chief engineer, Clinchfield.

At the second separate session of the B&B convention Joel W. DeValle, chief engineer, bridges and structures, Southern, gave a talk on "Use of Prestressed Concrete Components in Timber Trestle Maintenance" that was illustrated by a color motion picture.

During the final separate session of the convention, held on Wednesday morning, G. M. Magee, director of engineering research, Association of American Railroads, presented an illustrated talk on "What Heavier Wheel Loads on Bridges Will Mean to the Bridge Man."

Remarks by President Schlaf

It is well to remind ourselves of the reason for our existence as an association. Why are we gathered here? Our constitution states that the object of the association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities and other structures by investigations, reports and discussions. Let's not overlook the discussion aspect at this convention. You may raise a question from the floor concerning a problem that has plagued others present. Others may contribute their experiences with attempted or successful solutions. I believe that the key to the long life and success of our association is unthrottled floor discussion, conducted in an air of frankness and candor. If you do not agree with the conclusions reached by the special subjects committees, speak out.

I have outlined the aims of the association. Are we attaining our goal? Some criteria for determining this are: Whether or not we are maintaining interest as reflected by membership and whether or not we are maintaining the enthusiasm of our advertisers.

While our membership has dropped slightly in the past year, it is in line with the force reduction of railway supervisory personnel generally. As divisions are consolidated there is usually a corresponding reduction in the number of supervisors who are eligible for membership. Naturally, we want to increase in number. Let our motto be "every member get a member."

Our advertisers remain enthusiastic about our publication. Why the enthusiasm? Because an advertiser can put a half-page message before each member, delivered to his desk, for about five cents, which is less than he can get it to him by a letter. The advertiser wants his name before you when you reach for that requisition blank. He is helping your association. You should give his product thoughtful consideration.

And now let me give you some intangible benefits resulting from active participation in association affairs.

In the many years I have worked with the directors and officers of this association, I have found that almost invariably these men are promoted to positions of greater responsibility in their companies. I do not believe this is merely a coincidence. I believe that management recognizes an awakening of potential ability and a preparation for increasing responsibility. Management wants men who will work as a team. Management wants men who think clearly. Management wants men who keep abreast of the times and who want to learn how they can do the job better and more economically. I assure you that management prefers men who make things happen over those who watch things happen. Active participation in association work will develop latent abilities within you of which you are presently unaware.

I urge you to actively participate in association work. Volunteer for committee assignment. Some of my most rewarding experiences have been derived from association work. The greatest rewards have been the friendships I have developed with railroad men and railroad supply men all over the country. I want to thank them all for the help they have given me.

To stay in business, railroads must find a better way of doing the job. It is my sincere hope and belief that something you see or hear at this convention will help you do your job better.

Our supply friends are here with us and they are always looking for a better way to serve you. They want your suggestions.

Author Jonathan Swift said almost 2½ centuries ago, "Whoever could make two ears of corn, or two blades of grass to grow where one grew before, would deserve better of mankind, and do more essential service to his country, then the whole race of politicians put together." By the same token, the railway supply industry seeks to increase production and decrease cost. I salute them for their efforts and wish them continued success. Please give them your support.

Election of Officers

The following were elected officers of the association for 1964-65:

President—R. C. Baker, assistant chief engineer, Chicago & Eastern Illinois, Chicago Heights, Ill., who was advanced from first vice president; first vice president—H. M. Wilson, supervisor of structures, Pennsylvania, Chicago, who was promoted from third vice president; second vice president—R. D. Hellweg, assistant regional engineer, Gulf, Mobile & Ohio, Bloomington, Ill., who had been serving as a director of the association; third vice president—J. W. DeValle, chief engineer, bridges and structures, Southern, Atlanta, Ga., also a director. E. F. Snyder, assistant to chief engineer, Illinois Central, Chicago, and Mrs. Ruth Weggeberg were re-elected treasurer and secretary, respectively.

New directors of the association elected for three-year terms are: N. D. Bryant, assistant bridge engineer—construction, St. Louis-San Francisco, Springfield, Mo., and A. R. Dahlberg, bridge and building supervisor, Western Maryland, Hagerstown, Md. J. S. Ellis, supervisor of bridges and buildings and water service, Chesapeake & Ohio, Grand Rapids, Mich., was elected a director for one year to fill the unexpired term of Mr. DeValle.

New Committee Subjects

The new subjects selected for study by the association's special committees are:

1. Training Bridge and Building Supervisors
2. Steel Railway Structures—Methods of Protection from Corrosion
3. Prestressed Concrete Uses in the Railway Industry
4. Advantages and Disadvantages of Prefabricated and Portable Buildings
5. Timber Trestle Maintenance, Procedures and Equipment

Each committee will report its findings and conclusions at the 1965 convention, to be held on September 13-15 at the Conrad Hilton Hotel, Chicago.

TREASURER'S REPORT

SEPTEMBER 1, 1963 TO AUGUST 31, 1964

Cash Balance—August 31, 1963			$ 647.08
RECEIPTS:			
Dues—1965	$1,643.00		
Dues—1964	2,502.05		
Dues—Prior	175.00	$4,320.05	
Advertising:			
1962 Proceedings	$1,475.00		
1963 Proceedings	2,210.35	3,685.35	
Sales of copies of Proceedings		21.00	
Membership Certificates		3.00	8,029.40
Total Receipts			$8,676.48
DISBURSEMENTS:			
Salaries (Secretary and Assistant)		$2,129.40	
Social Security		70.51	
Stationery and Printing		593.93	
Postage		345.00	
Office Rent, Telephone, Electricity		292.57	
1962 Proceedings		1,847.78	
1963 Proceedings		1,909.15	
1963 Convention Expenses		305.19	
Office Supplies		47.80	
Embossing Membership Plates		29.00	
Miscellaneous		16.07	7,586.40
Balance, August 31, 1964			$1,090.08
Cash on hand First National Bank of Chicago, August 31, 1964			$2,782.11
Outstanding Check			1,692.03
			$1,090.08

September 8, 1964

APPROVED:

H. D. Curie
W. H. Huffman
W. A. Buckmaster

E. F. SNYDER, *Treasurer*

REPORT OF AUDITING COMMITTEE

TO MEMBERS OF THE
AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION:

Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period from September 1, 1963, to August 31, 1964, inclusive, and have found them to be correct as of the latter date.

Respectfully submitted,
H. D. Curie, *Chairman*
W. H. Huffman
W. A. Buckmaster

September 8, 1964

SECRETARY'S REPORT

ANNUAL REPORT OF MEMBERSHIP FOR PERIOD OCTOBER 10, 1963 TO SEPTEMBER 12, 1964

ACTIVE MEMBERSHIP:			
Total Active Members, October 10, 1963		656	
New Active Members since October 10, 1963		46	
Reinstated—Paid back dues		3	
		705	
LESS—Members reported deceased	1		
Resigned account retirement, etc.	15		
Transferred to Life Membership	10		
Dropped for non-payment of dues	42	68	
TOTAL ACTIVE MEMBERS—SEPTEMBER 12, 1964			637
ASSOCIATE MEMBERS:			
Total Associate Members, October 10, 1963		114	
New Associate Members since October 10, 1963		9	
		123	
LESS—Resigned account retirement, etc.	5		
Dropped for non-payment of dues	15	20	
TOTAL ASSOCIATE MEMBERS—SEPTEMBER 12, 1964			103
LIFE MEMBERS:			
Total Life Members, October 10, 1963		113	
Transferred to Life from Active Membership		10	
		123	
LESS—Reported deceased	7		
Transferred from Life to Honorary Membership	1	8	
TOTAL LIFE MEMBERS—SEPTEMBER 12, 1964			115
HONORARY MEMBERS:			
Total Honorary Members, October 10, 1963		4	
Honorary Member since October 10, 1963		1	
TOTAL HONORARY MEMBERS—SEPTEMBER 12, 1964			5
TOTAL MEMBERSHIP—ALL CLASSES—SEPTEMBER 12, 1964			860

September 12, 1964—rsw

REPORT OF NECROLOGY COMMITTEE

(1963-1964)

To the President and Members of

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION

We regret to advise that we have learned of the loss of nine (9) members through death during the year. It is possible that other members have passed away during the year of whom we have no information. If you know of any, we would like to have their names to include in the list to be printed in the Annual Proceedings. The following have been reported since our last Annual Meeting in October, 1963:

NAME	TITLE—RAILROAD	YEAR JOINED	DATE DECEASED
Active Members:			
E. F. Bateman	Bridge & Building Supervisor Union Pacific Salt Lake City, Utah	1958	July 26, 1964
F. E. Gladwin	Bridge & Building Supervisor Northwestern Pacific San Rafael, Calif.	1950	September 5, 1964

NAME	TITLE—RAILROAD	YEAR JOINED	DATE DECEASED
Life Members:			
M. D. Carothers (Ret.)	Chief Engineer Gulf, Mobile & Ohio Leawood, Kan.	1938	March 3, 1964
G. W. Hand (Ret.)	Assistant to President Chicago & North Western Park Ridge, Ill.	1909	January 13, 1964
E. L. Mead (Ret.)	Division Engineer Chicago & North Western Miami, Fla.	1923	November 2, 1963
A. N. Reece (Ret.)	Assistant to President Kansas City Southern Kansas City, Mo.	1922	January 8, 1963
W. G. Swartz (Ret.)	Engineer Accountant Canadian National Montreal, Que.	1917	1963
W. E. White (Ret.)	General Foreman Atchison, Topeka & Santa Fe Chanute, Kan.	1920	1963
C. W. Wright (Ret.)	Master Carpenter Long Island Malverne, New York	1908	November 22, 1963

We deeply regret the passing of these, our fellow members.
May we stand a moment in silence to honor these departed members.

Respectfully submitted,
E. R. Simmons, *Chairman*

September 12, 1964—rsw

REPORT OF RESOLUTIONS COMMITTEE

As we near the close of this Convention marking the end of the 73rd year of the American Railway Bridge & Building Association, it is fitting and proper that we recognize the special efforts of those whose time and contributions have made our 73rd year and this our 69th Convention an outstanding success. To recognize and acknowledge these special contributions we propose the following resolutions:

BE IT RESOLVED that the sincere thanks of the Association be extended first to Dr. Kenneth Hildebrand, Pastor of the Central Church of Chicago, who invoked divine blessings and guidance upon the activities of our combined associations.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to Mr. Arthur W. Grotz, President, Western Maryland Railroad; Mr. J. J. Wright, Director of Technical Research, New York Central; Mr. Allen L. Sams, Chief Engineer, Illinois Central Railroad; Mr. E. H. Hallman, Chairman, Western Carriers Conference Committee, National Railway Labor Conference; Mr. J. F. Griffin, Administrative Assistant, National Railway Labor Conference; and Mr. G. V. Guerin, Chief Engineer, Great Northern Railway for their informative, enlightening and inspiring remarks in addressing the joint sessions.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to Mr. J. M. Salmon, Jr., Chief Engineer, Clinchfield Railroad; Mr. Joel W. DeValle, Chief Engineer Bridges and Structures, Southern Railway; and Mr. G. M. Magee, Director Engineering Research, Association of American Railroads, for their informative special subject presentations.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of our Association be extended to the Association of Track & Structure Suppliers for its valuable support throughout the year and for the banquet and entertainment which is one of the highlights of the convention.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to the Management and Staff of the Conrad Hilton Hotel for their accommodating hospitality which contributed so much to the success of this convention.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to the Simmons-Boardman Publishing Corp. and its representatives for the excellent news coverage of Association activities and the convention.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to Mr. T. F. Burris, President, American Railway Engineering Association and Mr. A. L. Fridley and Mr. J. L. Beven of the Association of Track & Structure Suppliers who honored us with their presence and extended us greetings from their Associations.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to the following ladies who assisted at the registration desk: Mrs. Lillian Dick and Miss Pat Pietruszka of the Simmons-Boardman Publishing Corp.; Misses Barbara Daly, Pennsylvania Railroad; Judy McGarvey, Chicago & North Western; Marilyn Mawhinnie, Illinois Central Railroad; and Sandra Fuller, American Railway Engineering Association.

BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to Mrs. E. R. Schlaf and her committee who handled the ladies registration and reception.

AND, BE IT FURTHER RESOLVED that the sincere thanks and appreciation of the Association be extended to all committee chairmen and committee members who prepared and presented the interesting and informative reports; to the members of the Executive Committee, and finally to our retiring president Mr. E. R. Schlaf who has so ably and efficiently guided and directed the affairs of the Association during the past year.

We recommend that these resolutions be made a part of the Minutes of this Convention and be included in the Annual Proceedings, and that copies of these resolutions be presented to the parties concerned.

Respectfully submitted,
J. A. Goforth, *Chairman*
F. W. Hutcheson
H. M. Wilson

SPECIAL FEATURES OF B&B SESSIONS

Three illustrated talks of especial interest to bridge and building men were presented during the separate sessions of the B&B Association, one each day, to supplement the reports of the five Special Subjects Committees.

On Monday afternoon, the first day of the convention, J. M. Salmon, Jr., chief engineer, Clinchfield, gave an address on "Construction Methods — Spartanburg Terminal Company Tunnel," which was illustrated with slides.

The following afternoon Joel W. DeValle, chief engineer, bridges and structures, Southern, talked on the "Use of Prestressed Components in Timber Trestle Maintenance" and presented a color motion picture to illustrate his address.

On Wednesday Morning, the last day of the convention, G. M. Magee, director of engineering research, Association of American Railroads, gave an address entitled "What Heavier Wheel Loads on Bridges Will Mean to the Bridge Man." Mr. Magee's talk was illustrated with slides.

Here are excerpts from each address:

Construction Methods—Spartanburg Terminal Company Tunnel

The Clinchfield is known for many engineering feats, and to this list will probably be added the new cross-town tunnel recently constructed for the Spartanburg Terminal Co. at Spartanburg S. C., which was opened to traffic on June 27, 1963. This tunnel was not planned of recent years. It goes back to the very beginning of the South & Western Railway and Charleston, Cincinnati & Chicago Railroad, two of the forerunner corporations to the Clinchfield, at which time the necessary property, except for the crossing under the Southern Railway, was purchased.

Rail service at Spartanburg consists of four railroads. The Southern to the north and east from Washington, D. C., and Columbia, S. C., and to Asheville, N. C., and Atlanta, Ga., to the west and south. The Atlantic Coast Line south to Augusta, Ga., the Piedmont & Northern south and west to Green-

J. M. Salmon, Jr.
Clinchfield

wood, S. C., and the Clinchfield north to Elkhorn City, Ky.

The Clinchfield was projected to pass through Spartanburg on its way to Charleston and the sea coast. Many and varied routes were surveyed. The first Clinchfield location projected into and through Spartanburg was the location adopted for the terminal company's line. It was projected by a tunnel under North Church Street and the Southern. However, this early planning was not to accomplish what is being accomplished today. After the Clinchfield was formed in 1924 by the ACL and L&N, the tunnel project then became a means of connecting the Clinchfield, Atlantic Coast Line and Piedmont & Northern. In 1927 it was again activated, this time by the ACL and in 1930 authority was granted by the Interstate Commerce Commission, under Finance Docket 8471 to construct the connection. The Depression of the 1930's resulted in this construction not being accomplished.

The advent of World War II brought delay in the plans for constructing the tunnel. The matter was again progressed in 1951 and in 1958 the family lines under the corporate structure of the Spartanburg Terminal Co. were again authorized by the ICC to construct the tunnel at the exact location as was originally authorized in 1930. The P&N was authorized to operate thru the tunnel under trackage rights.

Authority from the South Carolina Public Service Commission was granted in 1962 and work actually began in April of that year.

It might be of interest to note that the project authorized in 1930 was estimated to cost $400,000, while the project as constructed and completed in 1963 actually cost $2,600,000.

The finished tunnel project is a horseshoe barrel with concrete floor, 800 ft in length, not greatly different from hundreds of other tunnels. However, it presented some rather unusual design and construction problems.

Normally with the shallow cover, which under the tracks of the Southern was only 10 ft, such construction would be performed by what is commonly called cut and cover, or open trench. However, the Southern required free and uninterrupted flow of traffic over all their tracks. This then required a bored tunnel. Because of the greater depth of tunnel under North Church Street, this section was also bored.

As a result of these requirements, the tunnel was constructed both by excavating a trench between driven steel sheet piling and by boring. Beginning at the north portal, which is just north of North Church Street, the first 50 ft, which included the north portal and its wing walls, was constructed in open excavation; the next 124 ft, that portion under North Church Street, was bored; the next 102 ft was open trench; the next 224 ft which was under the Southern was bored; and the remaining 300 ft including the portion under Magnolia Street, was in open trench.

Drainage in the vicinity of the construction normally flows north and east and presented no problem the way the tunnel was originally designed. The original design proposed that the tunnel roof be 5 ft below the Southern's tracks. This was not acceptable to the Southern, and as a result the tunnel was designed and constructed with a 10-ft minimum cover under the Southern. This increased the track grades to slightly over 1.7 per cent in each direction through the tunnel and lowered the lowest point to where the drainage had to be reversed and taken to the area under the P&N. This required an extensive drainage system with out fall under the floor of the tunnel, and a system of catch basins, gutters, etc., to collect the water and direct it to the drainage system. It also required damming off the rainfall in the long north approach cut, collecting it and reversing its flow northward underground to the normal stormsewer intake.

Soil conditions encountered were typical of the area. The geological formation is known as the Piedmont soil. This formation is typical of a wide area extending basically from Washington, D. C., to Atlanta, Ga., and lying on the southeasterly slope of the Appalachian range. Other than the top layer of soil which is principally decomposed vegetable matter from trees, etc., the remainder is either decomposed rock or rock.

In the tunnel construction the following soils were encountered:

First 10 ft—red micaceous silty sand

Next 10 to 20 ft—tan micaceous fine-grained silty sand.

Next 20 ft—red to brown medium-grained micaceous silty sand below these strata was encountered at varying depths a decomposed fine-grained schist which required drilling and blasting to excavate.

Under North Church Street was a deposit between the tan micaceous fine-grained silty sand and the red to brown medium-grained micaceous silty sand of light grey, medium-grained micaceous silty sand.

The soil is porous and ground water was encountered at all the formations, except the decomposed schist. Due to dewatering, particular attention was paid to surface settlement in the construction area. To avoid building damage, grout was injected into the foundation area of the drug store which was immediately adjacent to the open trench excavation.

The bored portion of the tunnel was performed using liner plates and rolled wide-flange-section ring beams. The liner plates were cold formed of ¼-in plate under North Church Street and 5/16-in under the Southern. Ring beams were 8-in wide flange sections weighing 35-lpf spaced on 48-in centers under North Church Street and on 32-in centers under the Southern.

The construction was carried out continuously around the clock and progressed by what is commonly called the three-bench method. The crown or top bench was progressed beginning at the center line by digging by hand and placing liner plate. Each successive plate to form one ring was placed and bolted and then a ring beam was erected. Pressure grouting was performed between the excavation line and the liner plates to distribute soil pressure and avoid settlement. To further avoid possibility of settlement under the Southern, poling plates were jacked ahead of the excavation for erection of the liner plates. These plates supported the roof excavation by having their leading ends inserted into the soil and their trailing ends resting on the last liner plate. Grout was injected above the poling plates.

After the top or first bench was progressed entirely under the Southern, a needle beam was supported on cross wide-flange beams welded to the longitudinal wide-flange beams which in turn were welded to the ring beams. The ring beams at the crown were then strutted to the top of needle beam. At the entrance, the crown was carried by cantilever of the needle beam as the second or middle bench was excavated. As liner plates were completed a ring beam was bolted to the suspended ring beam and caught off at the second bench.

When the second bench had progressed some 25 ft the third bench was started. The first and second sections of the ring beam were carried on the needle beam by struts until the third section of ring beam could be placed and caught off. Due to the tunnel's finished floor details, this bottom ring beam, which completed the entire horseshoe, was supported on concrete, using high-early-strength cement and anchor bolts.

This entire steel shell had the structural strength to form the tunnel and support the overburden and live load. Because of electrolysis, rust and possible damage from a derailment, a reinforced-concrete lining, in itself capable of complete support, was poured inside the ring beams and liner plates.

The design used for liner plates and ring beams will not be found in college text books. It has been developed through theory and experience over the years by R. V. Procter and T. L. White of the Commercial Shearing & Stamping Co. of Youngstown, Ohio. This theory, printed in 1946, entitled "Rock Tunneling with Steel Supports" was adapted to the soil conditions encountered on this job.

To further provide economy in construction, the liner plates and wide-flange ring beams were cold worked to their final shape. This resulted in increasing the ultimate limit of the ordinary structural-grade rolled steel from 60,000 to 72,000 psi and practically eliminates the yield point. In the design, maximum working stresses of 24,000 psi were permitted.

Live loads and their distribution are typical for this type of structure. Live load used was Coopers E72, which is 72 kip axles on 5 ft centers Dead load was assumed to be 120 pcf, which was average soil weight.

Use of Prestressed Concrete Components In Timber Trestle Maintenance

J. W. DeValle
Southern

The use of plain and creosoted timber material in trestles is a practice which has been long established on American railroads.

On the Southern, we have many miles of structures with these components, with which we work daily. Their merits and faults are fairly well understood and appreciated. The faults are as follows:

(1) Wood is always subject to fire hazard.

(2) Wood is relatively soft in cross grain bearing, and must be protected to minimize crushing and abrasion.

(3) Decay often results in spite of careful treatment. In fact, many times decay may begin before treatment and continue after.

(4) Some species are subject to seasoning checks and splits, frequently beyond the depth of treatment, thus providing ready entry for decay organisms.

(5) The quality of present-day structural

lumber is not as high as in the past, when we had large stands of virgin long-leaf yellow pine available in plentiful supply on our territory.

There are other faults which I am sure occur to you, but we should not lose sight of some of the merits of timber, which are as follows:

(1) Lumber is fairly easy to obtain.

(2) If properly graded, seasoned and treated, decay can be postponed for a long time.

(3) Many of our people are familiar with framing procedures, and are fairly well qualified to work such material.

(4) Lumber is generally lighter and easier to handle than other construction materials.

(5) Mistakes in fabrication of lumber components can generally be corrected easily on the job.

(6) Timber is generally more flexible and can deflect without a serious risk of fracture.

If we balance the merits and faults, it is plain that neither so generally overwhelms the other as to prohibit the future use of lumber, or to eliminate the possibility of using other types of materials. However, the generally rising cost of creosoted timber and the necessity for frequent replacement, when weighed against the practical, assembly line production of other materials, has led us on Southern to look for a substitute material. We have not been prejudiced in our search, but have so far limited our consideration to concrete and steel, since such are more readily available at a generally lower cost.

Three different components of timber trestles seem to us to be fit subjects for investigation relative to the use of alternate types of materials in repairs.

The first of these components is the familiar blocking used as a foundation for timber trestle bents. As all of you bridge men here today know from experience, timber blocking is subject to deterioration from many sources, such as moisture which softens the fibers and promotes growth of decay, termite action, fire loss, crushing from the superimposed loadings and others. Blocking is expensive to replace and should be eliminated, wherever practical.

The second of the three components considered was the timber cap. The bearing of the pile heads against the underside of the cap limits, in many cases, the load which can safely be supported by the bent, because of the crushing of the grain of the cap. It can easily be seen that the cap is the weakest part of the bent, and any improvement at this point may substantially reduce the cost of future maintenance.

The third component we thought susceptible to replacement was the open-deck trestle tie. As you know, an open-deck trestle tie has only three functions, namely: (1) Act as a gauge rod to hold the rail in alignment; (2) provide a smooth supporting surface for the rails; and (3) distribute the rail load to the supporting stringers. The timber tie has some defects which should be eliminated, such as a tendency toward softness under the tie plate, surface checking and splitting, and high cost of installation.

In our consideration of a substitute material for timber blocking, concrete was a natural. It answered all our objections to timber, and seemed to offer no faults of its own. We have test installations of precast concrete blocking that have been in place for more than five years, and our only regret is that we do not have more.

We were not so easily convinced in our search for a substitute for the timber cap. We had to balance size, weight, cost and future maintenance expense between concrete and steel. We quickly found that initial cost variations were small, and despite the heavier unit weight of concrete we decided to test it first because of expected lower cost of future maintenance. I believe, however, beyond the maintenance angle that there is little else to consider when choosing between steel and concrete.

It is not as practical to use steel ties as a substitute for timber, as it is to use steel caps as a replacement for timber caps, because of the difficulty and expense involved in insulating the signal circuit. Concrete trestle ties appear much more suitable.

I know that many of you are primarily interested in cost, as indeed, we on Southern are. We realized, however, that the break must be made with old habits and beliefs, and therefore the sooner we started, the better. Comparative costs of the concrete components we decided to use were higher because of the necessity to write off form costs, etc. A timber cap for a five-pile bent cost us about $53 while the prestressed concrete cap for the same bent was $82. An 8-in by 8-in by 10-ft creosoted oak trestle tie, dowelled, cost us about $11 each, while the prestressed concrete ties were $19.88 each.

Future concrete costs will be considerably reduced, because of lower form costs and improved design. I look forward to a future concrete trestle cap and tie which will be as cheap as timber, when installed.

We have purchased and tested the first precast, prestressed concrete ties ever to be installed on open-deck trestles so far as we know. These ties were divided into two groups for testing under different conditions. One hundred were placed on an open-deck trestle which carries a large percentage of 100-ton coal cars in a climate which ranges from very cold to moderately hot. Another test involving 100 of these ties has been made on our Lake Pontchartrain trestle, where the climate is extremely hot, under welded rail in signal territory. These last ties were sub-divided into two groups of 50 ties each in order to attain the effect of two additional firebreaks.

The concrete ties which we have used are 8-in wide, 7¾-in deep, and 10-ft long. The depth was chosen in order to match existing tie sizes, so that the concrete ties would be interchangeable with existing ties. The reinforcing in these ties consists of four wire cables, ⅜-in in diameter, with ¼-in diameter hoop bars spaced at intervals to prevent bursting or splitting of the ties. Stainless-steel threaded inserts are cast in the top surface of these ties to receive bolts which fasten the tie plates and the guard timbers in place. Holes are cast vertically through the ties to take drift bolts to fasten the deck to the stringers. These are ⅞-in in diameter.

The rail is attached to the concrete ties by bolts which secure the tie plates, and by spike heads which are shop welded to the tie plates on alternate sides of the rail. A new type of tie pad, made of hard plastic, was used under the tie plate to provide signal insulation, and to prevent the steel tie plate from damaging the concrete. Cost of this pad was only 37 cents compared to 54 cents for the usual self-sealing pad used on timber ties. The life of the plastic pad is expected to equal the life of the concrete tie, whereas the life of the more expensive pad used on timber ties ranges from only 2 to 15 years.

Creosoted timber guards were used to space the concrete ties in the usual manner, because of economy and ease of handling. As you know, we are able to get almost complete penetration of creosote in this size member, which will result in long protection.

What Heavier Wheel Loads on Bridges Mean to the Bridge Man

In 1940, our (AAR) Research Center started extensive investigations to determine the impact effects in bridges. These investigations were started because of the operation of high-speed steam locomotives with large overbalances in the drivers, the high-speed diesel locomotives and the development of electric strain gages which made possible the accurate measurement of stresses at high speeds. Previous strain gages were of the mechanical type and subject to vibrations resulting in possible instrumental errors, but the electric gages are free from these errors.

A review of all previous investigations was made and a decision reached to secure a large number of readings on each of many different types and lengths of bridges under both steam and diesel locomotives at speeds varying from 5 mph to the maximum permitted. The stresses determined with the locomotives operating at 5 mph were considered the same as would be recorded with the locomotive standing on the bridge. Hence, all impact values were taken as a percentage of those stresses recorded at 5 mph.

Considerable variation was found in the impact effects for the various spans, even for spans of the same length and under the same locomotives.

In this investigation of steel bridges, several thousand stresses have been recorded and the American Railway Engineering Association will make recommendations for impact factors within the near future. These recommendations will include factors for both steam and diesel locomotives operating over either open or ballasted-deck bridges for all types of beam or girder spans. In general, the impact percentages will be reduced from those previously used. For example, our research has shown that a locomotive or heavy car will not "bounce" in a vertical direction and roll about a longitudinal axis at the same time. The previous impact factors considered that this action could occur simultaneously.

G. M. Magee
AAR

It is obvious from the various design loads and impacts used during the years that each railroad will have bridges of different carrying capacities. For example, a large number of our bridges were constructed from 1900 to 1910 during the rapid expansion of the railroads. During this period some of the bridges were designed for Coopers E44 while others were designed for E50, and to make the situation more confusing, very few of the locomotives in operation looked like the design locomotives.

What did the bridge engineers do about this confusing situation? They realized that the bridges could not be replaced or reinforced every time the design loads were changed. Consequently, they established a method of rating each bridge in terms of Coopers loading. In general, this method consists of:

(1) Determine the carrying capacity of the bridge.

(2) Determine the live-load and impact carrying capacity.

(3) Determine the live-load capacity.

(4) Determine the bending moment produced by Coopers E1 loading.

(5) Determine the rating.

The ratings of the bridges have now been explained but what about the locomotives? As previously stated, very few of the locomotives in operation look like a Coopers locomotive. However, bridges are not affected by the appearance of the locomotives but by the stresses produced by their axle loads. To solve this situation, bridge engineers established the system of Coopers equivalents for all loads passing over the bridges.

The Coopers equivalent in bending for any particualr system of axle loads and spacings is determined as follows:

(1) Calculate the bending moment produced by the particular system of axles.

(2) Determine the bending moment by Coopers E1 loading.

(3) Calculate the Coopers' equivalent of the diesel locomotives by dividing the bending moment produced by the particular locomotive.

The bridge departments of most of the railroads have computed the rating of all their bridges and the Coopers equivalents of all their locomotives.

What does the bridge engineer do when the Coopers equivalent of a particular locomotive exceeds the rating of the bridge? The first step is to reduce the speed of the locomotive over the bridge. The result of this action (in addition to receiving a telephone call from the operating department) is to reduce the impact in the bridge and thus increase the live-load bending-moment capacity. If this action is not sufficient to safely carry the particular locomotive then the bridge must be reinforced or replaced with heavier-designed steel. The same must be done if the speed reduction cannot be tolerated on a permanent basis.

Within the past few years, there has been a gradual increase in the weights of the loaded railroad box cars, hopper cars, tank cars, flat cars and other special cars to carry unusual loads. Our Research Center prepared an electronic computer program to calculate the Coopers equivalents of most of these cars. Tables showing the Coopers equivalents for these cars have been distributed to member roads. Some of these special cars have axle loads as large as 75,000 lb, spaced at 4-ft 6-in centers. The Coopers equivalents for such cars are as large as E93 for 40 to 45-ft spans.

The increased carrying capacity of a bridge obtained by using higher unit stresses in the steel depends entirely upon the proper inspection and maintenance of the structure. Each inspector should realize that the bridge under inspection is undoubtedly subjected to occasional stresses larger than the original design stresses and the proper functioning of the bridges depends upon every detail and main material working as a unit. The same precautions apply to timber and concrete bridges, as well as steel bridges.

As you know many of our steel bridges were built over 60 years ago and experience has shown that any failure can be expected to occur at the following critical points:

(1) Floorbeam hangers. Any failure in such members usually occur at the top of the member on a section through the lower line of rivets. A small crack will start at the edge of the hole under the rivet head and progress toward the outside edge of the member. In pin-connected members, the crack will usually start where the outstanding legs of the channel have been removed in order to secure clearance for the member.

(2) Stringers and floorbeam connection angles. The rivets in the upper part of such connections tend to become loose and in many cases the rivet heads pop off. Any cracks are usually found in the fillets of the angles.

(3) Loose I-bars. Each I-bar of a member is designed to carry equal loading but if one bar is loose the other bar or bars may be overstressed. The amount of load carried by each bar can be easily determined and the load carried by each bar can be readily adjusted by methods recommended by the AREA.

(4) Expansion bearings. Expansion rollers should be observed under the passage of a train to make certain they are in working condition. Such rollers may become "frozen." due to dirt accumulation and corrosion and tend to slide on the bearing plates. Any restraint by the rollers introduces additional stresses in the members.

(5) Corrosion. Any structure subjected to the brine from refrigerator cars will undoubtedly have considerable corrosion on the top flanges and web plates. Rivet heads and the top flanges of girder spans should be inspected for loss of section. The webs of floor beams receive considerable brine and such plates may become very thin.

(6) Fillets and webs. The deflection of the timber ties and deck timbers produces bending stresses in the fillets of the flange angles and in the web plate between stiffeners just below the angles. It can be seen that the stresses at these locations are repeated many times and may result in fatigue cracking of the steel.

(7) Abutments and piers. The older bridges were usually built with a full-width sole plate sliding on a masonry plate. The end stiffeners were over the edges of the plate. The deflection of the girder resulted

in most of the load being carried by the inside stiffeners with high bearing stresses on the masonry. Many years of service resulted in an abrasion of the masonry and in many cases cracked and broken masonry. This usually occurs when the edges of the plates are close to the edge of the masonry.

(8) Timber trestles. Many of the timber trestles are 40 to 50 years old with occasional trestles about 60 years old. Such bridges naturally require close inspection. The first item to inspect is the alignment and cross level of the track on the trestle. A poor alignment or cross level usually indicates some trouble, such as settlement of the piles, crushing of the caps, loose bracing, and in some cases failed stringers.

You are all acquainted with the boring of holes in the piles and caps to determine internal decay. We are in hopes that a simpler method of inspection can be worked out in the future, such as using a nuclear or ultrasonic instrument, thus eliminating the boring method. Particular attention should be directed to the piles at the ground line for possible external decay, especially if there has been any change in the level of the water or ground.

Extensive investigations have been conducted in the Research Center laboratory to determine the static and repeated load strength of timber stringers. These investigations have indicated that such timbers will fail in bending only under high overloads but will fail in horizontal shear under repeated loads slightly greater than design loads. Horizontal shear failures are readily detected in the outer stringers of the chord but are difficult to detect in the inner stringers. Since the bending strength of a stringer that has failed in horizontal shear is only half that of a good stringer, it can be seen that the stringer chord may be overstressed.

Difficulties are frequently encountered with loose bolts fastening the sway and longitudinal bracing to the piles and caps. These bolts are usually ¾-in in diameter and are too small for the forces involved, resulting in worn and enlarged holes in the timber members. Our research has shown that a 1-in diameter bolt will carry over twice the load carried by a ¾-in diameter bolt when the loads are repeated The replacement of these bolts with 1-in diameter bolts will stiffen up the structure.

(9) Concrete bridges. Many of our concrete bridges are 40 or 50 years old and it is unfortunate that most of them were built in an era before control over the amount of water per sack of cement was attained. Another cause of severe deterioration in some areas was the alkali in the water used to mix the concrete as well as in the soil in contact with the completed structure.

Concrete deterioration is usually evident from the underside of a bridge span, and in some cases the reinforcement may be exposed. Such deterioration will usually start where the two slabs forming the span are in contact along the center line of track, particularly if the deck does not have proper drainage. For this reason, the drains should be inspected and kept in good condition.

Several years ago our Research Center conducted static loading tests on some concrete slabs that had been removed from a bridge on account of very bad deterioration. These slabs still carried over 3½ times their original design load before complete failure occurred. While the bottom surface of the steel reinforcement in these slabs was almost completely exposed due to concrete deterioration, the steel was still bonded to the concrete sufficiently well for the slabs to act as reinforced-concrete beams. The serviceability of such structures appears to depend upon the amount of bond remaining where concrete deterioration has occurred.

The design and rating of bridges is a complicated subject, far more technical than the data I have presented in this paper. However, I hope you have a better understanding of: (1) How and why the bridge engineer designs a bridge for Coopers loading for diesel-locomotive and heavy-car operations; (2) how the carrying capacity and rating is determined in terms of Coopers loading; and (3) how the Coopers equivalents of the locomotives and cars are determined in terms of Coopers loading.

Abstract of Addresses Delivered Before the Joint Session

The first featured speaker at the opening joint session, held on September 14, was W. Arthur Grotz, president, Western Maryland. His address was entitled "Competition—Will it Make or Break You?" and included the following comments:

Remarks by W. A. Grotz

You men are parts of many managements. I am going to talk to you about basic management problems of competition and opportunity as if I were talking to our own annual management conference. Much of what I say will be my own predictions.

The railroad industry has a value at its original cost less depreciation of about $26 billion. Since much of the investment was made many years ago, the reproduction value would be much higher. Ours is a very big industry.

In 1963, the railroads took in $9.6 billion in revenues. That sounds like a lot to you and me, but it is actually less than the railroads took in in 1953. Revenue per net ton mile decreased from 1.48 cents in 1953 to 1.31 cents in 1963 in the face of a rise of 18 per cent in material and fuel costs and 47 per cent in wage rates of railway labor in the same period. The railroad industry has fought hard to stay even and many individual companies have suffered losses. I selected the title for my talk, "Competition—Will it Make or Break You?", because of this recent earnings' trend. Serious as the problems are, I hope to show you that the adverse phase of the cycle has bottomed out and that the future of the railroads is as bright as we have the determination and resourcefulness to make it.

The competitive forces which limit the revenues of the railroads are familiar to all of you. I shall list them briefly as a background against which to discuss ways to improve the earnings of the railroads. They are as follows:

(1) Greater truck competitive capacity through additional expressways.

(2) Development of pipe lines for bulk commodities other than petroleum and gas.

(3) Low-priced residual oil competing with coal and electric transmission lines of 500,000 kw or higher, with reduced line losses of power, competing in energy transmission with coal in hopper cars.

(4) Government-fosterd atomic power.

(5) Continuing governmental development of inland waterways.

(6) Air transport, aided by governmental development of larger aircraft, airports and navigation aids.

(7) Industrial decentralization, involving less transportation of products and improved industrial processes.

Looking at the competitive situation broadly, however, I am happy to say that, except for atomic energy, we are past the uncertainties of competing with new kinds of transportation. We need no longer fear competitive surprises. The other modes have now matured, with roughly predictable capabilities against which we can plan our strategy.

The relative growth of other modes of surface transportation is leveling out. Understanding and use of advancing scientific knowledge by one mode or another will continue to affect its success. There is every reason to believe that greater recourse to science will be helpful to the railroad industry. I speak not only of physical science, but also of the science of management. Our success will depend upon our greater utilization of both—people no less than machines. Science is our brightest hope.

The future competitive struggle will find the railroads with the advantage of mergers into a smaller number of systems. They will have, therefore, broader and more skilled management, intensive use of their best facilities, with lower unit costs, closer sales coverage and greater financial resources.

I have said "Science is our brightest hope." Although the railroad industry embarked late and cautiously on research, it is moving at an increasing tempo. This is an area of great interest to me. I predict that science will become a major preoccupation of railroad management.

With emphasis on science, we can expect continued reductions in costs, which will further improve the competitive position and profits of the railroads. Better materials, better designs and better physical characteristics will flow from expanded research. Science will become evident in wider acquaintance with, and use of, mathematical reasoning, the so-called "Systems Planning" and "Operations Research" approaches. Not less important will be work measurement standards, cost analysis, management training and long-range planning. Less frequently will a manager be selected because he is the best salesman or the most senior mechanic. To the greatest extent feasible, he will be specifically selected for management characteristics and educated to be a manager. Happily, some railroads have been sending men to management schools. More will go.

Recognizing that engineering must be kept abreast of science, railroads are exploring the means of refreshing and stimulating their valuable engineering staffs, so many of whom are here today. Such training or retraining will steadily reduce the alleged devotion to archaic methods and the indifference or hostility toward innovation, for which our industry was criticized a year ago by the National Academy of Sciences.

The drive for more education, especially higher learning, is one of the great forces in the world. Colleges and universities must be increasingly associated with the railroads in the fields of science, of research and of recruiting and training personnel.

A more constructive and more balanced governmental policy toward transportation is dawning. Federal, state and local governments are becoming more actively interested in the welfare of the railroads. There has been presidential interest in equalizing the regulatory burdens of the railroads with those of other carriers and in making grants-in-aid to metropolitan mass transit. When the railroads have experienced periods of particular distress, government financing through loans or guarantees of loans has been available. Government is expanding its study of a suggested super railroad from Boston to Washington. Government is financing an operations research study of the Long Island Railroad commuter service. I firmly believe that grants-in-aid to railroad research and development will be in the public interest.

There are hopeful signs of moderating the taxes on railroad property. Government has done so in a number of local cases.

With such an economic and political background, where do you engineers and roadmasters and B&B men fit? How can you make even greater contributions?

You are important in the railroad system. Your work pretty largely determines the speed and dependability of train service, without which there can be no bright future.

I would counsel each of you, first of all, to be optimistic, to believe so thoroughly in the future of your business that you are a builder-upper—a salesman of railroad success. Mountains may be moved by faith, but faith and enthusiasm can make your work in moving mountains far more effective.

Second, be receptive to new ideas. Read and discuss technical papers in your field at every opportunity. Thank God for your intellect and never stop learning.

Third, I know that you use your best efforts to get maximum use of the expensive equipment entrusted to you, but if you ever see a way of getting extra utilization, mention it to your supervisor or put it in the suggestion box. The return on investment is of utmost importance to top management. Maximum utilization of maintenance-of-way equipment is just as important as engines and cars. Our industry cannot afford to have a comfortable cushion of tools or rolling stock to make up for lack of coordination.

In turn, management must help you through research and development of materials and of off-track equipment by more scientific programming of work and trains and such training as may be appropriate.

Finally, take as keen an interest in politics as do the truck, waterway and airline men. It may be hard for many of you to realize how important political attitudes and pressures are to a vast industry like ours. Take my word for it. If you don't know your congressman, make it a point to find out about him. Write him on matters of concern. When he votes helpfully, write him expressing your appreciation. Everyone likes praise. The publisher, B. C. Forbes, wisely said, "A work of appreciation often can accomplish what nothing else could accomplish." Help to get out the votes. We are blessed with a government of the people, but it can't guess what the electorate wants. It is responsive to the views of those, often minorities, who take the effort to communicate.

Remarks by A. L. Sams

The first speaker at the Tuesday morning joint session was Allen L. Sams, chief engineer, Illinois Central, who spoke on "Let's Take a Look." Here are some excerpts from his address:

One of the most remarkable changes that has taken place in the railroad industry since World War II is the mechanization of maintenance-of-way work. I can recall serving as a track supervisor 20 years ago on our Mattoon district, a 125-mile branch line in southeastern Illinois. There were 16 sections on the district and frequently two extra gangs. Except in one or two locations where men were not available, the minimum-size section gang was six men. Today there are four sections on that district and the normal force consists of a total of about 14 men.

In 1948, Class I railroads paid for a total of more than 663 million man-hours chargeable to maintenance of way and structures; in 1963, the comparable figure was 218 million man-hours, a reduction of 67 per cent. The reduction in track-maintenance forces has been even more remarkable. While I do not have such figures for all Class I railroads, the results on the Illinois Central should be fairly representative of the industry. We reduced man-hours chargeable to the track-maintenance accounts from 11.5 million in 1948 to about 2.5 million in 1963, while total ton-miles handled on the railroad in 1963 remained about the same as in 1948. In other words, one track laborer in 1963 performed the equivalent work of about 4½ men fifteen years earlier.

The significance of this accomplishment can be better appreciated by showing its effect on net income of the railroads. The net cost of a labor man-hour, including fringe benefits, in 1963 was about $1.50 after income taxes. If the reduction of more than 445 million man-hours had not been made by Class I railroads, the net income of 652 million dollars in 1963, a relatively good year, would have been completely dissipated.

Where do we go from here? Have we now reached the ultimate limit of mechanization and innovation in our work or will the next 15 years produce as many improvements as the last 15? How will our jobs as managers and supervisors be affected?

To answer the second question first, I think we would all agree that we have not reached the ultimate limit yet. As long as opportunities exist, and as long as ingenious men are challenged by these opportunities, the process of innovation will continue. I doubt if there is a man in this audience who cannot point to an operation that could be improved or made easier by mechanization. The research continues, both on the railroads and by the suppliers. New machines, materials and processes are still being introduced. There is every indication that wage rates will continue to rise, providing additional economic incentive for substituting machines for man-hours. Without doubt, we will see many more advances in mechanization in the near future.

How extensive will they be in the next 15 years? Predicting the future is always difficult, but it is necessary for intelligent forward planning. The first thing to consider is volume of traffic we can anticipate. As I stated earlier, 1963 traffic load was about the same as 1948. During that period, total inter-city freight net ton-miles of transportation provided by all carriers increased from one trillion in 1948 to 1.5 trillion in 1963, while the railroads' share of the total decreased from 64.3 per cent to 43.1 per cent. Unless a serious depression occurs, transportation requirements of our country should increase another 50 per cent during the next 15 years. The political climate is improving. Our efforts to compete more effectively should bear fruit, and I believe we can stop the downward trend and hold our present share of freight transportation. My guess is that productivity of maintenance-of-way labor, measured by gross ton-miles per man-hour, will be twice as great in 1978 as it was in 1963.

For my purpose today, it is not necessary to be quantitatively accurate in predicting labor productivity. The point I want to make is that it has increased substantially since World War II and will probably increase in the future.

How will this affect our performance as supervisors and managers? It has often been said that a railroad's employees are its most valuable asset. It should be fairly obvious that the value of these employees increases with their productivity. Generally speaking, every employee wants to perform a given task well. There is no substitute for the satisfaction of knowing that a job has been done well. Less than satisfactory performance results only when the man was not well suited to the task, when he was not properly motivated or not properly trained. Eliminating motivation, because the most important element in motivation is salary and this is largely beyond our control, I would like to discuss during my remaining time employee selection and training.

Railroad employees are noted for their loyalty to the industry. There are relatively more 50-year veterans of railroad employment than any other industry. Moreover, with fewer employees at the level of laborer, a larger percentage of these must advance to more responsible positions. Therefore, it is of utmost importance to choose new employees carefully. The previous practice of hiring almost everyone who had two arms, two legs and a Social Security number can no longer be tolerated.

When a railroad buys a mechanized tool, the purpose is to improve the quality of work and perform a particular operation in a more efficient manner. The railroads have spent millions of dollars in new work equipment of every description during the past several years. This equipment is now being used by track and bridge and building gangs. Each of these tools or machines requires a varied degree of skill to make it perform to capacity.

During this period, it seems that the only thing that has not been changed is man. He is our immediate problem and the question now is what are we doing about him. Man is able to do something a machine, no matter how sophisticated, can never do. He is able to think. We take it for granted, but it *is* rather extraordinary.

There is something else even more extraordinary which we probably never think about. Man is a machine operated by electrical impulses from a central control station —the brain. He is entirely unique because he is the only machine that does not require outside direction to operate. Isolate him from any contact with his fellow man without communication of any sort and he can still continue to function. Isolate a machine, even the latest type, most highly developed electronic computer, and it would be inoperative until supplied with electric power and human direction.

Man, having the power to think, requires something additional in order to operate this new work equipment. He needs more knowledge of a special kind which we in management must supply. It is an area where we need to concentrate more of our efforts. We call it training.

Most railroads have instituted programs at the supervisory level to develop better work methods and better supervisor-labor relations. It seems to me we need to consider a training program at the labor level which would include the rudiments of motor operation, both electric and gasoline, working parts of these units, engine failures and what to look for to correct these failures. In other words, the trainee should have a general working knowledge of what makes the machine operate in order to prevent breakdowns and to reduce down time when one occurs.

The training should embrace all types of machines used by the railroad, their functions, general method of operation and minimum production requirements. It should include some instruction on the under-lying reason for the operation performed by each of the machines and its relation to the overall program. Finally, we need to devote more time to acquainting this class of employee with the duties and functions of other employees, both in the maintenance-of-way department and in other departments.

The railroads are passing through a period of great change. We have seen how the efficiency of our work has been greatly increased during the past 15 years, and can anticipate more in the years to come. Our society needs the dependable, economical transportation offered by the railroads Our part in fulfilling that need is to provide and maintain the fixed property in a condition to handle more and faster trains. This is the challenge facing us as managers and supervisors. I believe we are ready to meet it.

Reads E. H. Hallmann's talk

Following Mr. Sam's address, those attending the second joint session heard a talk prepared by E. H. Hallmann, chairman, Western Carriers' Conference Committee, National Railway Labor Conference. Since Mr. Hallmann was unable to attend the meeting, his talk was delivered by J. F. Griffin, administrative secretary of the NLRC.

The address was entitled "Methods of Obtaining the Maximum Benefits from the Settlement in the Work-Rules Case in the Use of Self-Propelled Equipment" and included these comments:

For many years you gentlemen have been deeply interested in a situation that was causing you a great deal of concern and considerable unnecessary expense. I refer to those situations where for one reason or another you were required to have a pilot, or more than one pilot, on your self-propelled machines. Many in this audience have talked to me on several occasions about the necessity of doing something about this situation. As all of you know, something has now been done, and it is covered by Article III of the Agreement of June 25, 1964, between the Nation's railroads and the five operating Brotherhoods.

You gentlemen have been working under the terms of this Agreement for nearly three months, and I know you are more familiar with how it actually operates than I am. I feel that this is a workable agreement and briefly I would describe it as follows:

(1) The rule governs the manning of self-propelled vehicles or machines by train service employees (conductors and brakemen) used in maintenance, repair, construction or inspection work. The organizations were fearful that we might be trying to use one of these machines as a switch engine or a road locomotive, which is the reason for limiting its use in this connection to maintenance, repair, construction or inspection work.

(2) This Agreement does not require the employment of engine and train-service employees where they were not required prior to the effective date of this agreement.

(3) On one of these self-propelled machines operating in road territory, a conductor only need be employed on on-rail self-propelled vehicles when operating in main-line territory, provided such machines are equipped with a drawbar and are operating under train orders. There are several points to be watched here. First, it applies only to "on-rail" machines; secondly, it applies only in main-line territory and not on other parts of the railroad, such as, but not limited to, siding, spurs and branch lines.

I am sure that you gentlemen, by working closely with your local operating officers, will not be put to any great unnecessary expense under the provisions of this rule.

In yard service, you will only be required to use a yard conductor (foreman) on on-rail self-propelled machines provided such machines have sufficient power to move freight cars, and if more than two cars are handled at any one time, a yard brakeman will also be employed. Inasmuch as this Article does not apply to the operation of these machines in such areas as shop tracks, supply areas, tie yards and installations of that type, I am sure that you will likewise, by working closely with your local operating officers and yardmasters, be able to plan your work so that very little, if any, unnecessary expense is involved. You will also observe that this, too, only applies to on-rail machines.

The rule does not require the employment of a locomotive engineer or fireman on any of the self-propelled vehicles, where they had heretofore not been employed. However, it developed that on some railroads there were practices or agreements that required the employment of a locomotive engineer to actually operate the machine in the performance of all of the work for which such machine was designed. An example of this would be on those railroads where the locomotive engineer actually operates the Sperry Rail Detector Car. Also on one large eastern railroad the locomotive engineer has operated what is sometimes known as the wire inspection train, which, as I understand it, is the equipment that is used in the inspection of the overhead catenary system. We could not find any situations where a locomotive fireman was used, although one of the earlier awards of the Adjustment Board required the employment of a locomotive fireman on a steam-propelled pile driver on one railroad. It was our information that this carrier, after being saddled with this unnecessary expense, scrapped the equipment involved so that they were no longer compelled to use a locomotive fireman. The organization insisted, however, that a reference be made in this agreement that would not throw them out of court in case this carrier again attempted to use this obsolete equipment.

All in all, I feel that you now have something that you have long wanted and needed. I feel that your patience in living under the old rules and practices was one that you tolerated all too long. If I had any part in relieving you of this unnecessary expense, I am pleased to have played that part. But I do want to thank you and all of your fellow officers for the wholehearted support you gave us in making it possible to reach the agreement we have been discussing this morning.

Remarks by G. V. Guerin

The final feature of the Tuesday morning joint session was an illustrated address by G. V. Guerin, chief engineer, Great Northern. He spoke on "What Record Floods Did to the Great Northern's Main Line in Montana and How It Was Rebuilt." Here are some of the highlights of his talk:

A series of pyramiding factors reached a climax in early June to cause all-time record highwater and flood conditions in the Rocky mountains, located in northwestern Montana. Snowfall in the winter of 1963-64 was substantially greater than average with a total of 420 in being measured at the Marias Pass crossing of the Continental divide. Low temperatures delayed the spring thaw and runoff from snow melt was still heavy in early June.

During the period June 6-8, 1964, unprecedented warm rainfall occurred in the area—8 in to 10 in was reported by local observers. The combination of these conditoins resulted in a record runoff from the mountain slopes into ravines, creeks and rivers, which have steep gradients and narrow, confined channels, to create devastating high water and flood conditions.

At high water, the middle fork of the Flathead river usually flows at a depth of about 20 ft and at an elevation of 7 ft below top of rail in Belton canyon. High water in June reached an elevation of 23 ft above top of rail to completely fill the bores of 2 tunnels. It would have taken sizeable bridges to handle water from sidehill ravines where culverts 12 in to 36 in in diameter have taken care of drainage at these locations since the line was constructed in 1891.

The most extensive and serious damage occurred on the main line between St. Paul and Seattle exending wetsterly from Summit (Marias pass on the southern border of Glacier park) 45 miles to Belton, located at the southwest corner of Glacier park. Two other locations a few miles west of Belton also sustained damage. Two secondary main and two branch lines located to the south and east of Glacier park where damaged to a lesser degree by high water in the Marias, Teton and Sun rivers and Spring Creek. Estimated cost to restore these lines was $300,000.

The flood damage and restoration work for the section of main line between Summit and a location a few miles west of Belton on the primary main line is divided into these three different types:

(1) Washout of culverts and adjacent roadbed, which was constructed of sand, silt and gravel, located on sidehills and in ravines which drain the mountain slopes into creeks and rivers.

(2) Slough of embankment slopes constructed of sand, silt and gravel caused by erosion of toes of slopes by high water moving at fast velocities in adjacent streams.

(3) Scour of ballast, earth and loose rock embankments, which are located in narrow, confined stream beds, by large volumes of water in streams flowing at high velocities.

Considerable other damage was associated with the situation. The track structure was washed into streambeds or left suspended over washed-out holes and culverts, snowshed footings were washed out, and communication lines and signals were destroyed. It was fortunate that important bridges suffered only minor damage. Highways, including US2, also were completely washed out so that railroad restoration work had to be accomplished by working from each end.

The first evidence of any trouble was reported early in the morning of June 8 when a freight train encountered a washed-out culvert near Essex, about 20 miles west of Summit. An empty stock car was lost in this washout. It immediately became evident that a serious situation was developing and top officers of the railway, including President J. M. Budd, Vice President-Operations T. A. Jerrow, General Manager Lines West C. M. Rasmussen and the speaker arrived at the area within a matter of hours.

Since the track and highways were washed out, inspections to appraise the damage and to make plans for restoration work had to be made on foot and in the air. Small aircraft and helicopters were utilized to very good advantage. Even though the water in the stream beds was still in flood stage, and some of the damage was hidden, plans for restoration work, together with estimates on materials, equipment, supervision and labor, were formulated based upon past experience with similar situations of lesser magnitude. These items were either on the way or on the ground by the night of June 9.

A work schedule was arranged which called for two 12-hour shifts, 7 days per week. Experienced supervisory personnel, consisting of general, track, bridge and building, communication, signal and equipment-maintenance supervisors, were moved to the scene from various locations on the railroad.

Damage at the easterly end conformed to type (1) for the 15 miles of double track. There were 10 major washouts of embankments consisting of sandy silt and gravel ranging in size from 100 ft to 800 ft in length, and from 15 ft to 100 ft in depth. One large washout 500 ft long and 100 ft deep required 175,000 cu yd of fill material. These 10 major washouts, together with minor washouts and embankment-slope restoration work required an estimated 650.000 cu yd of filling material, 22,000 cu yd of riprap, one mile of new track, including ties and ballast, and several thousand feet of 24-in to 60-in diameter culvert pipe with flumes. In addition, 60 lin ft of creosoted showshed roof timbers, posts and caps were dislodged and deposited into a washout cavity. The cavity was caused by water cascading over the shed roof and washing out the track and footings below.

Practically all of the washouts for the easterly 15 miles were located on sidehills composed of sand, silt and gravel soil. Repairs were made by starting bulldozers on the natural slopes above the washouts and pushing material into the washouts by establishing benches and working the material downhill. Since all highways were also washed out, the work had to be progressed from the easterly end, one washout at a time, and operations moved to the next one west as each was completed. A total of 20 bulldozers were used for this work. Most of them were obtained from contractors and several were company owned and operated by company employees.

The most severe and concentrated damage occurred over a section about 5 miles in length immediately east of Belton, located at the southwestern boundary point of Glacier National Park. Most of the damage in this area conformed to type (3). Here, the track is constructed adjacent to the middle fork of the Flathead river in a narrow canyon and the rampaging river reached such a high elevation that it completely filled the bores of 2 of the 4 tunnels located in the canyon. Considerable track was deposited in the river channel when the ballast and loose rock and earth roadbed were washed out down to solid rock in this 5-mile section. All of the communication lines, and most of the signals, were also lost. US Highway 2 is located at a higher elevation than the track and it remaind in serviceable condition. It provided access to establish several working faces from which to carry out track restoration work. More than 100,000 cu yd of grading using rock and gravel for fill was required to restore the roadbed. Considerable of the original track material was recovered for reuse in reconstructing the track after the water receded, but about 1½ miles of new rail, fittings and track ties also had to be used.

Restoration work was started in full swing on June 10 and completed sufficiently to permit resumption of traffic 19 days later. A maximum of about 400 men were employed.

In summary, the major items of all work consisted of approximately 1,300,000 cu yd of grading (including about 100,000 cu yd of rock), production and placement of 220,000 cu yd of riprap, installation of 4,000 lin ft of 24-in to 60-in diameter culvert pipe and flumes, construction and placement of about 6 miles of track and ballast (including 2½ miles of new material), construction of 10 miles of communication lines and restoration of signal systems at the affected areas. Most of the grading, culvert and track reconstruction work was accomplished in the first 19-day period. None of our employees was killed or injured as a direct action of the flood. It is estimated that the cost to restore the section of line from Summit to 10 miles west of Belton to its original physical condition will amount to about $2,500,000, exclusive of operating costs for detouring trains and other similar transportation expenses.

Most Economical Method of Renewing Bents Without Disturbance to and from Traffic

Report of Committee

COMMITTEE—R. A. YOUNGBLOOD, *Chairman,* proc. supt. b. & b., CofG, Savannah, Ga.; M. M. RAY, JR., *Vice Chairman,* asst. gen. fore.-b. & b., StL-SF, Tulsa, Okla.; V. D. RAESSLER, *Vice Chairman,* supvr. b. & b., IC, Memphis, Tenn.; H. BRUNS, des., IC, Chicago; R. H. CARPENTER (ret.), engr. m. of w., MP, St. Louis, Mo.; S. A. COOPER, ch. engr., GM&O, Mobile, Ala.; E. W. HARRIS, gen. b. & b. fore., AT&SF, Ft. Madison, Iowa; M. J. HUBBARD (ret.), asst. ch. engr, C&O, Huntington, W. Va.; J. E. HUTTO, gen. brdg. insp., SAL, Savannah, Ga.; W. LEDYARD, div. engr., NYC, New York; D. R. LUSSI, rdm., A&WP, Atlanta, Ga.; H. R. MACDONALD, asst. b. & b. mast., CNR, Winnipeg, Man.; A. D. MCKANNA, gen. fore. b. & b. and w. s., AT&SF, Newton, Kan.; C. H. NEWLIN, engr. brdgs., SOU, Charlotte, N. C.; B. J. ORNBURN, asst. ch. engr.-struct., CMStP&P, Chicago; R. E. PEARSON, drain. engr., IC, Chicago; P. E. SCITES, asst. supvr. b. & b., C&O, Hinton, W. Va.; J. E. SCROGGS, pres., RAILWAY TECHNIQUES, INC., Kansas City, Mo.; W. R SHAFER, struct. des., SP, Houston, Texas; E. R. SHULTZ (ret.), engr. m. of w., PRR, Philadelphia, Pa.; E. R. SIMMONS, asst. engr. brdgs., SP, San Francisco, Calif.; E. F. SIMONSON, b. & b. supvr., SI, Sandpoint, Idaho; W. STANCZYK, des., CMStP&P, Chicago; C. E. WACHTER, b. & b. mast., CNR, Port Arthur, Ont.; R. WALL, b. & b. supvr., SOU, Selma, Ala.

Due to the wide divergance of physical characteristics that have to be taken into consideration when renewing bents, this report will include only the open-deck timber trestles. It is to be acknowledged that in most cases involving the renewal of bents other than in frame structures, each has to stand on its own merits as to type and method of replacement. Also to be acknowledged are the structures on those railroads over which it is neither practical nor possible to interrupt traffic. In cases such as this, it is necessary to place false bents for carrying traffic while bents are being replaced.

The renewing of bents without disturbance to and from traffic is of vital importance to our railroad industry today. In performing bridge work, not only are "face costs" to be considered but also of equal importance—and sometimes even more so—are the delays to traffic. Therefore, any plan involving the renewal of bents on a main line must take

R. A. Youngblood
Chairman

into consideration not only initial and maintenance costs but traffic delays as well.

There are various methods of renewing bents on a bridge. The method used depends not only on economics and traffic delays but also on the type of the opening, the drainage, and the structure. For example, the opening could be: (a) year-around deep water, or (b) alternate wet and dry. Type of drainage could be: (a) swift water, (b) contain large drift, (c) still water, (d) combination. Type of structure could be: (a) steel, (b) concrete, (c) ballast-deck, (d) open deck, (e) combination. Based on the above physical characteristics, the method of bent renewal should be chosen accordingly. As stated above, for the purpose of this report, the method discussed will be for an open-deck timber trestle.

Assuming that all the different factors have been considered, such as age of structure, height, whether main line or branch line, tonnage carried, speed and particular type of use of the structure, and, if it is over a stream, the amount of drift that passes through the bridge, one railroad would replace an open-deck trestle bent that had deteriorated above the ground line with a sawed timber frame bent as follows:

First, assemble all needed material at the work site and place in position for use. Place the proper order consistent with MofW and operating rules. Frame the bent on the ground alongside the trestle. In this case, it is assumed that the cap is in good condition and will remain on the bent. Swing the work scaffolds in place alongside the bent to be replaced. On the adjacent bents (the ones on which the jacks are to be placed to raise the structure), fasten the ties and stringers together with a chain and load binder just inside each rail so that the jacks that are placed on opposite ends of the same cap and are jacking against the ties, will raise the entire structure (rail, ties, stringers and, in this case, the cap) from the bent to be framed out. Remove stringer bolt nuts from the two bents on each side of bent to be replaced. This work should be done, but the jacking process will not begin until after the train has passed. Saw guides should be placed properly for the correct cut off of the old piles in the bent.

A jack should be fastened to each outside pile just under the cap in order to raise the cap the thickness of a hacksaw blade so that the drifts can be cut just as soon as the train passes. The jack can be removed as soon as the drifts are cut. The new mudsill should have holes drilled for the drifts prior to placing on the cutoff bent as well as templates for locating the framed post quickly. Templates should also be placed on the cap to remain in place so as to facilitate placing the upper ends of the framed posts. New holes should be drilled for the drifts through the old cap alongside the old drift bolts. All this planning is working toward a predetermined time for the passage of a particular train. The moment the train passes, the gang proceeds as follows:

A highway-rail bridge truck is placed on the track at the nearest crossing and proceeds to trestle. The two jacks on the caps of the adjacent bents are activated and the structure raised until it is in a strain at the bent to be replaced. The two jacks on the batter or outside piling raise the cap off the piles the thickness of a saw blade and a hydraulic hacksaw is used to cut the drifts, leaving no stub on underside of cap. These jacks are then removed and the hydraulic chain saw is placed on the cutoff guides and begins cutting the piles. These piles are held while being sawed and when lowered to the ground by the bridge truck's hydraulic boom. The entire bent is handled in this manner. The cut timber is treated with hot creosote and the mudsill is then placed by the bridge truck, drifts are driven and the framed posts are put in their proper places on the mudsill and located under the cap in their templates and then drifted to the mudsill.

At this point, if train time makes it necessary, the bridge truck moves to the crossing and is removed from the rails. The jacks on the adjacent caps are lowered and the bent is now located properly. Drifts are driven through the cap, stringer bolts replaced and the bridge is ready for traffic. Braces of any nature, if necessary, can now be placed and all tools can be removed as well as templates. The bridge is now ready for normal service.

Tools used: Highway-rail bridge truck with hydraulically extended boom
Hydraulic chain saw
Hydraulic hacksaw
Hydraulic auger
Hydraulic impact wrench
Hydraulic bolt puller
Hydraulic jacks
Sledge hammer, etc.
Labor force: One working foreman
Three laborers

With this method, about thirty minutes is consumed in work time after the passage of trains before trestle is ready for another train.

Epoxies properly applied to the ends of posts and piles at the junction of pile to sill and post to cap gives a much better bearing surface as compared to felt applied to the top of piles and exposed ends of piles and posts mopped with hot tar and creosote oil.

One Railroad reports that a frame bent can be placed in an open-deck trestle for 75% of the cost of redriving and in a ballast-deck trestle for about 50% less.

Another company says, "Most of our bent renewals have been complete renewals of bridges."

The above outlined procedures are general only. Each situation will present its individual problems which will require slight variations. The essence of the entire procedure is the proper advance planning of each step to be taken. The order of sequence and having the proper materials, tools, and equipment available, are of prime importance in seeing that a job is well done.

Latest Developments in Fire Prevention Methods and Materials for Bridges, Buildings and Timber-Lined Tunnels

Report of Committee

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J. A. Jorlett
Chairman

This report comprises information on the types, merits and some costs of fire-resistant materials, chemical weed control and other fire protection and control. We were also directed to determine the type of fire protection in use in long timber-lined tunnels and long, high, timber trestles in isolated areas. Recognition of fire hazards has been foremost in the association's report program. Over the years many worthy reports have been prepared. Your committee regards a bibliography of this coverage and certain other pertinent studies a worthwhile part of this report. It must be added here that alternatives or substitutes for combustible construction materials were not considered to be within the scope of the report.

Many owners of properties including railroads have a belief that the manner in which to minimize fire-prevention efforts and eliminate fire hazards is to build structures of noncombustible materials. We all know this is no guarantee. Fires do happen and casualties do occur in such structures but the structural elements are rarely if ever a factor. After a study of fire in fire-resistive buildings over the last 50 years, the National Fire Protection Association declared that the structural framing of a building has a very minor influence on loss of property or life. Actually responsible are such things as combustible contents, flammable interior finishes, unprotected floor openings, exits improperly arranged and constructed, and poor housekeeping. Most of us have first-hand knowledge of damage to unprotected steel structures and even reinforced concrete structures during conflagrations.

Although many of today's bridges are built of non-combustible materials, the wood pile trestle and timber ballasted deck, all of treated materials, is least expensive to build and has a long service life with a low annual maintenance cost. Many of the present such structures were built of treated materials which are vulnerable to fire damage. Advancements in the art of fighting fires on trestles and in timber-lined tunnels in formerly inaccessible areas have been assisted indirectly by the improvements and increased number of off-track equipment used to maintain track and structures. This has brought about the construction of more passable roads leading to or paralleling the railroad tracks. Fire-fighting equipment can now be brought close to the scene of a fire more quickly. Many communities possess efficient fire-fighting companies with high-powered pumpers and chemical trucks. Where water supply is limited, tank trucks augment the pumpers.

In the western part of this country where much of the mileage of timber trestles is located, the U.S. Forest Service has pioneered in the use of borax slurries distributed by airborne equipment to fight forest fires. In 1960 over 6,000,000 gallons were used on some 1000 woodland and forest fires in the West. The equipment used carried from 60 gallons to 2000 gallons. They come in over fires and drop the slurry from a height of 50 to 75 ft. Three advantages are claimed for the slurry: One, coating excludes air so that flammable materials cannot ignite; two, white coating reflects heat so that the fuel does not reach ignition temperatures readily; three, borate salts themselves are effective fire retardants although the exact mechanism is not fully understood. Disadvantages of the method are that equipment cannot work in high winds or at night and the cost is high. Materials cost about $95 per ton, f.o.b. at plants which comes to about 15¢ per gallon when mixed with water. Added to this is transportation and handling costs to the airfields. Airborne equipment can run up to $500 per hour.

Various railroads have improved the installations of fusible cables or links for detection of fires on important trestles or wood-deck structures particularly at critical locations. The cables or links carry a current which is interrupted when a break in the continuity of the system is caused by high temperatures. The interruption causes an alarm to be set off in a tower, dispatcher's office or set a roadside signal to stop trains. Because the system is susceptible to breakage it is looked upon with disfavor by some of the railroad supervision.

This type of protection has been ingeniously applied in timber-lined railroad tunnels. One western railroad has such a detection system with rolling doors at the tunnel portals tied to it. After the alarm is sounded one of the doors is closed automatically. The other is closed manually after it is determined that no one is in the tunnel.

A mid-western railroad has in use stored pressure-loaded stream 2½-gallon fire extinguishers on three of its important steel bridges having timber decks for use of its personnel. The advantages found for these extinguishers are as follows:

(1) The "loaded stream" extinguisher is saturated with dissolved potassium salts so that it will not freeze.

(2) While 2½ gallon pump-type water extinguishers have an Underwriters' Laboratory rating of 2A, which is the same rating given for a 50-gallon fire barrel with three fire buckets, the loaded stream extinguisher has the same rating plus fire-killing power for oil and grease fire equivalent to that of the 1½-quart carbon tetrachloride extinguisher.

(3) There is no corrosion problem as contrasted with extinguishers using calcium chloride to prevent freezing.

(4) There is no evaporation problem as there is with the pump-type extinguisher.

While dry-pipe fire lines are not a new application for fire fighting on railroad bridges and long trestles, they are looked upon with favor by fire-fighting organizations. The lines must be properly sized and provided with connections for pumpers at accessible locations usually at the ends of the structures. At intervals along the structure hose outlets are provided. Connections are made for the standard 2½-in fire hose and sometimes 1½-in hose. Proper lengths of hose in weatherproof boxes are located at each connection. The smaller diameter hose enables employees to get to a small fire quickly where a pressure water supply is tied in with the dry-pipe system. Anyone who has helped drag hundreds of feet of standard fire hose along a trestle or open-floor bridge will appreciate the spacing of numerous hose outlets along the structure. When a movable span is included in the structure, it will be necessary to have quick-connect non-corrode fixtures at each end of the movable span.

Fire retardants

In discussing fire-retardant treatments for wood it should be kept in mind that there are two distinct aspects of fire performance. One is fire spread and relates to the rapidity or freedom with which fire spreads over a surface that has been ignited. The other may be termed fire resistance and relates to the tendency of fire to penetrate a member or structure. The manner and extent to which the spread of fire is retarded and in which penetration of fire is resisted are often closely related. Many railroads have undertaken studies and tests to develop methods of fireproofing timber structures. The earliest attempts were with coatings which endeavored to keep the timber temperatures below ignition point of both the timber itself as well as the preservative material when the ignition source was present. Latest advancements in the science is the combination of fire-retardant chemicals with or without preservatives.

A great deal of work has been done in the advancement of the quality of Fire Retardant Treated (FRT) wood by the Forest Products Laboratory of the U.S. Department of Agriculture, Underwriters' Laboratories, Factory Mutual Laboratories, Southwest Research Institute and a number of universities such as University of California, Ohio State, Columbia, and others which have the necessary test furnaces. The AAR Research Department in Chicago in conjunction with the AREA has had many noteworthy projects, both on-the-job performance and laboratory investigations of materials and practices in fire prevention. The ASTM has established tests to judge the suitability of materials from a fire safety standpoint.

Recognition of the worthiness of FRT wood has come from the numerous code-writing authorities of cities and other bodies, such as government agencies (the Federal Housing Administration, the Army and the Navy), the International Conference of Building Officials in their Uniform Building Code. These sources of information should be investigated by you when you plan to use FRT wood, either in new projects or replacements in existing structures.

The use of liquid bituminous based coatings on decks, applied either by spraying or brushing, for fire retardation has been common practice for several decades. This had its usefulness in protecting existing treated (petroleum-creosote) structures. While they have been effective in varying degrees on horizontal surfaces, they have not been successful on vertical surfaces. This can be overcome by using a glass fabric tape impregnated with a liquid fire retardant. The tape is patented. The tape is applied by stapling it to the piling, timber bents and the like. It is expensive both in material and cost of application.

One noteworthy series of tests of coating materials was made by the Santa Fe Railway in 1957. The Santa Fe, who had been active for many years in the study of fire prevention for their timber trestles, which in 1957 numbered about 128 lineal miles, devised a full-scale single-track trestle replica, one span in length for a typical fire test. The structure consisted of a ballasted timber-type deck spanning a bent of piling and a timber backwall. Douglas fir lumber and piling which was air seasoned to approximately 20% moisture content was treated with a 50/50 creosote-petroleum mixture two to ten years prior to test. After the structure was built, tests were conducted using two phosphorus-type proprietary compounds. The coatings were sprayed on to a thickness of 1/16 in. and 0.07 in. respectively. The test was made by piling tumbleweed under the trestle to a height of five or six feet at the bent and decreasing it to about two feet at the backwall. The ground was sloped upward in a typical manner at the backwall.

About 45 sec after the tumbleweed was ignited, the fire reached its peak temperature. Readings taken at a point immediately below the deck reached 1650 deg F or higher. The weeds burned out about 1½ min after ignition. The flames continued on the piling and timber for 12 to 14 min with the temperatures in the last 10 min or so remaining at some 500 deg F. The fires then died out except for some local burning which persisted in protected pockets. It is interesting to note here that the temperature of a five-minute fusee used by our trainmen reaches a temperature of 3350 deg F.

Equally successful tests were made on the same type of structure when the timber and piling were treated with a solution of another proprietary phosphorus-type additive in a 50/50% creosote-petroleum mixture. The net retention of the piling was 20.56 lb per cu ft of the solution or 0.189 lb of phosphorus, and the net retention in the timber was 15.18 lb per cu ft of the solution or 0.140 lb of phosphorus. Phosphates were selected for the test because they retard the burning and spread of fire to the point that the wood will not continue to burn when the ignition source is removed or exhausted. Many water-soluble chemicals, such as ammonium sulphate, borax, boric acid and zinc chloride, have fire-retarding properties, but they are more or less leachable so that for exterior exposure and periodically wet conditions they are not satisfactory.

Tumbleweed was arranged under the trestle in the same manner as the foregoing tests and ignited. The same temperatures were reached at the height of the burning. In this test however the flames on the timber and piling died down in about eight minutes except for small protected areas. Char measurements were 1/16 in to ⅛ in on the piling and ⅛ to ¼ in on the timber.

Some of the conclusions stated for the tests were:

"Early testing showed less fire hazard on untreated timbers than treated timbers. Studies showed that the higher the retention of preservative oils, the greater the hazard, for as you increase the fuel, the fire hazard increases. From this, we believe that an increase in the ratio of fire retardant to oil is necessary as the total oil is increased.

"We also noted that the most persistent flaming always occurred in protected locations where entrapped heat could cause volatile materials to burn above the wood surface and away from the phosphate additive, thus indicating a need for a flame-controlling agent.

"From the above, we have concluded that phosphorus as triaryl phosphate contributes materially to reduction of the fire hazard. Phosphorus-halogen mixtures in the proper ratio to preservative solutions will increase the control."

A full description of this report with photographs and other descriptive information appears starting on page 1098 of Volume 61, AREA. The report was given by L. C. Collister, manager. Tie and Timber Treating Department, AT&SF.

Chemical control or eradication of vegetation around structures and storage areas

The presence of weeds and grasses around railroad structures invites widespread disaster to many railroad properties. As late as May of this year several blocks of waterfront operations along the Hudson river were wiped out when a fire started in a little used stock yard. The weed fire was brought under control in short order by the Jersey City Fire Department. Brisk northwest winds apparently carried burning embers across eight or nine tracks of a Pennsylvania railroad float bridge yard and lodged them in a multiple-track high coal-unloading trestle. In the matter of several hours the trestle, five timber and steel float bridges, a long wooden covered pier, a timber-decked three-track open pier and a part of another multiple-track lighterage pier were in blackened ruins.

During the past decade the railroad industry principally through the efforts of the AAR Research Department cooperating with AREA Committee 1—Roadway and Ballast—exhaustively tested liquid and soil chemicals for controlling or eradicating weeds, grasses and brush. Three types of chemicals were tested: (1) Contact herbicides, (2) translocated herbicides, and (3) soil sterilants.

A contact killer is one that is capable of killing all of the top growth of the plant with which it comes into contact. There are selective and non-selective contact weed killers. The selectives may kill only certain species in a mixture of plants while the non-selective may kill all of the plants.

Translocated herbicides are applied to a plant and are carried through the stem to the roots, which are destroyed or badly damaged. Translocated herbicides are usually selective and do not work on all grasses and weeds.

Soil sterilants are used to keep an area free of all vegetation for a period of time. This type of material is used primarily in yard areas, around bridges and trestles, communication poles, signal stands, buildings, road crossings, and as spot treatments for noxious weed control. Several of the common chemicals used for this purpose are arsenicals, borates, boron compounds, petroleum residues, salt and sodium chlorate. Borates and boron compounds, because of their safety features, are probably the most widely employed chemicals used around and under wooden structures. The concentrated borate ore has no harmful effects on the bridge ties, piling, or hardware. It is easy to apply on areas commonly found under bridges, around piling, on slopes, and other areas where it is desirable that all vegetation be removed.

Most of the eastern United States has adequate rainfall and a long enough growing season to produce heavy plant growth. This is especially true in the southeast. When trees are removed from an area brush, woody vines and strong perennial grasses soon infest the area. In addition, there is sufficient rainfall to quickly leach most soil sterilant from the soil. In extremely low rainfall areas it is possible to obtain two years control with mixtures containing toil-sterilant-type chemicals.

Information concerning granular materials shows that good results are obtained and that the materials are non-inflammable and non-poisonous. A good combination in controlling deep and shallow rooted plants is sodium chlorate (35%-40%), sodium metaborate (50%-60%) as a fire retarder for the chlorate, combined with a highly insoluble product. The chlorate penetrates deeply into the soil controlling the deep-rooted plants. The highly insoluble products do not leach into the soil as readily, thereby giving a longer residual on the soil surface and keeping out seedlings which germinate later in the season.

Some of the disadvantages of the materials are that the chemical does not become effective until rain dissolves it; heavy rains sometimes carry the chemical away before it can dissolve and leach into the soil; and the rate of application must be heavier to be as effective as pre-dissolved sterilants.

The costs for the granular materials depend on the areas. In the southern areas, with a long growing season, the application is about 400 to 800 lb per acre. Costs will be about $120 to $240 per acre in place. In the northern region with its shorter growing season, the application is from 200 to 600 lb per acre. Costs will be from $80 to $160 per acre in place. The costs are decisively affected by the means of distribution. If the materials can be applied with powered equipment and transported in large volumes handily, the costs can be surprisingly lowered.

The lists of chemicals and chemical combinations for vegetation control or eradication become longer each year. There are probably some 100 such materials being offered.

Mentioned earlier in this report was the increasing recognition by code-writing groups permitting the use of FRT plywood and lumber in buildings. In New York City where large amounts of FRT plywood and lumber are being used for temporary facilities, barricades, formwork and other miscellaneous needs in the reconstruction of Pennsylvania Station, diligent care is exercised by the City Building Department to see that only acceptable material is delivered to the job. No material can be unloaded from a truck unless a qualified inspector is there to inspect it and keep a record of the shipment.

The development of the phosphorous compounds for the treatment by impregnation has permitted increased use of the materials for outdoor use. Many single-story buildings have been built using FRT plywood roof decks on glued laminated beams and purlins. The square foot cost of this type was about 60% of the cost of a roof type with steel bar joists, girders, insulation and ceiling fireproofing of the conventional roof. The FRT plywood comes in T&G type for roofing so that common roof coverings can be applied to the surface.

Along with the improvement in FRT materials improvements are also being made in fire-retardant paints. These are available in interior, exterior, floor and deck enamels, flat finishes, and sealers for over FRT wood and aluminum. These paints may be brush applied or sprayed.

Inspection and Maintenance of Timber Trestles for Increased Wheel Loads

Report of Committee

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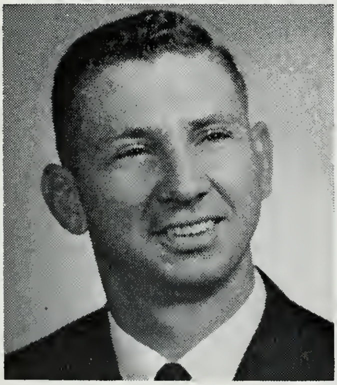

N. D. Bryant
Chairman

In the past few years the railroads of this country have been called upon to handle a greater number of cars with increasingly heavy wheel loads. Not only are the wheel loads becoming heavier, but the number of cars carrying heavy loads are increasing with a rapidity approaching arithmetic progression. Loads that formerly were considered too heavy to be handled without special investigation and approval are now being transported over our rails regularly as a matter of course. From the traffic viewpoint, this is a decided advantage because of the increased business, but it has presented some maintenance problems in our bridge structures. In a great many instances the same timber trestles that occasionally carried a heavy load a few years ago are now carrying them regularly with no change in design or additional strengthening.

Most railroads have established single four-axle carload limits for main line, secondary branch line, and other classes of territories, over which these loads may be transported without special approval. At the present time the most common four-axle carload limit for main-line territory is 263,000 lb gross. One railroad that handles a considerable number of heavier loads has a load limit of 286,000 lb without special approval, and at least one line has a 300,000 lb limit. Some thought is being given to raising the limits on some roads that presently have the lower limits.

In addition to heavy wheel loads that are handled regularly without special approval, many railroads report that, of those loads requiring special approval, 45% to 95% are greater than 350,000 lb. Several lines occasionally handle multi-axle loads in excess of 1,000,000 lb with one line reporting loads of 1,200,000 lb being transported at times.

Even though actual stresses in existing trestles are increasing in direct proportion to the increase in loads, and likewise actual deflections are also greater, present design stresses being used are mostly consistent with AREA specifications. The primary variance with AREA recommendations occurs in bending stresses with most roads using 1,400 psi to 1,900 psi with no impact. One line, however, uses a design bending stress of 2,300 psi with allowance for 60% impact in open-deck trestles and with 40% impace for ballast-deck trestles.

To determine the extent to which existing timber trestles must be strengthened to carry the heavy wheel loads, it is necessary to determine what stresses should be allowed. The permissible stresses for passing heavy loads range from 1,800 psi to 2,400 psi bending stress with no allowance made for impact. A permissible stress of 2.530 psi bending with 60% impact in open-deck trestles and 40% impact in ballast-deck trestles was reported by one line.

Heavier wheel loads, greater frequency of these loads, and higher speeds, coupled together, produce additional maintenance problems. Although some railroads believe that speed alone will not appreciably shorten the life expectancy of timber trestles, it is generally felt that the combination of these factors will have a decided effect upon the longevity of timber in bridges. A common practice is to require a speed reduction over timber trestles for heavy loads that produce higher stresses. With a high degree of maintenance, including good line and surface, tight bolts, and properly maintained approaches, the load-speed-frequency factor has little apparent effect upon timber life expectancy. But on the average road this high degree of maintenance is not practiced, so it is found in actual practice that the above factor produces mechanical wear in timber, crushing in caps and stringers, and pumping in piling.

In recent years it has become harder to secure suitable pine for long large-dimension structural bridge timber and some roads have had to switch to fir for these timbers. Timber Agents for railroads are finding it harder in recent years to secure sufficient large-dimension structural timber that is acceptable to maintenance men. Even though most lines are presently using the same stress grades of timber for the various trestle components as was used several years ago, some roads report that they are now receiving inferior timber which is softer, greener, and with more splits and checks. This type of timber fails to give satisfactory service when used where the load-speed-frequency factor is found.

In view of the increasing frequency of heavy loads, it becomes apparent that the factor of safety of existing bridges is being appreciably decreased. When the existing trestles were constructed, many years ago, a certain factor of safety was built into them. In the intervening time, loads have been increased considerably, so that the factor of safety for these bridges has been reduced proportionately. However, it has become necessary to reappraise the safety factor in the interest of economy. Experience has shown that the safety factor built into existing structures could be decreased and still safely carry the heavier wheel loads. But this efficiency angle must be delicately balanced with the safety viewpoint.

Since wheel loads have become increasingly heavier in the last few years, it would seem likely that inspection methods would have changed likewise. However, the inspection methods of some roads have not changed in this period. The trend is for those lines handling the heaviest loads to make timber trestle inspections more intensively and more frequently. Inspections are made by visual inspection, sounding, increment boring, power drill, and one railroad uses a nuclear-ray instrument for inspecting timber trestles. The greatest change in inspection is in intensity and frequency. Inspection of timber trestles range from continual to semi-annual, with the majority of raidroads reporting that bridge inspections are now made monthly or at shorter time intervals. Other than the bridge inspector, the number of persons making timber bridge inspections hasn't changed appreciably in the last ten years. That is, with only a few exceptions, the same ones make inspections now that formerly did. Where a change has been made, it is towards an increase in the number of personnel making inspections. The frequency of inspections by supervisors has not changed in the last 10 years on a large number of roads, but some lines report that daily inspections are now made by supervisors.

The trestle members given the closest inspection, those members showing the most rapid deterioration or failure, and the type of failure of the members naturally varies with the territory through which the railroad operates, and with the intensity of heavy loads handled. The lines which handle heavier wheel loads with greater frequency, place more emphasis on inspection of caps and stringers than do other roads. Close attention is also given to inspection of piling, posts, sills and ties, usually in that order of importance. Apparently the surface of trestle approaches affect the maintenance of the bridge since some roads also include the approach surface on their list of items inspected. Caps and stringers are also showing the most rapid deterioration or failure, with some piling also showing signs of incipient failure. However, in the case of piling, it appears that decay has already weakened the pile before failure attributable to heavy wheel loads occurs. In the foregoing classification would fall those trestles composed of timber treated during the period 1941-1945. Because of the press of time, improper seasoning and faster treating cycles occurred, and possibly a poorer grade of preservative was used during this period.

The majority of timber failures are progressive failures, that is, with a noticeable change in the condition of the member. This type of failure occurs after decay once starts, but the decay pattern seems to have slowed down in the last 10 years due to better treatment. Many lines report that the type of failure hasn't changed in the last 10 years, but again the parallel between the frequency and intensity of heavy loads and type of failure holds true. The roads handling greater numbers of heavier loads are experiencing an increase in the rate of progression of failure in the last 10 years. This is attributed to increased wheel loads coupled with the increased age of the trestles.

The procedure for analyzing bridge-inspection reports for determination of when and how replacement is to be made has not changed as a result of increased wheel loads. This procedure of analysis is the same now as it was several years ago. Common procedure is for the results of the inspection to be progressed from the General Foreman or B&B Supervisor through channels to the Bridge Engineer or Engineer of Structures and finally the Chief Engineer.

Experienced judgment remains the most widely used criterion for evaluating timber conditions and the need for replacement. A few lines have certain fixed limits that ascertain when bridge timber is to be replaced. When the remaining sound timber falls below these fixed limits, the member must be replaced. In addition to judgment and fixed limits, other criteria are used such as the age of the trestle, the amount of excessive maintenance, the need for greater waterway opening, logs and floating drift to be passed, amount of trains and their speed, anticipated bridge gang work, and correlation of bridge gang program.

Ties, caps and stringers, in that order, are the members that most frequently need replacement in open-deck thestles, while in ballast-deck trestles the members most frequently requiring replacement are caps, piling and ballast curbs. Of the members requiring replacement, a majority of replacement is due to normal timber deterioration. However, the trend is for a greater number of replacements to be required by accelerated mechanical wear and by accelerated fatigue failure on those roads transporting heavier wheel loads. Only in a very small percentage of the time is replacement due to overstress failure at this time.

A great majority of those railroads furnishing information to this committee report that the ballast-deck type of timber trestle construction most adequately supports increased wheel loads with a minimum of maintenance. They conclude that this type trestle is easier to surface and line, and that it provides a better distribution of axle loads to the supports. The ballast-deck trestle also gives a longer service life with appreciably reduced maintenance. One drawback to this type trestle is the greater difficulty in replacement.

Most lines report that there is no indication that today's loads are causing piling or frame bents to settle. However, the greater frequency heavier wheel load carriers are experiencing settlement in piling. Likewise, the alignment is the same for settlement which was caused by steam engines versus today's heavy loads. While a majority of roads state that today's settlement in piling is not as great as that caused by steam engines, those lines handling a great number of heavy wheel loads report that piling settlement is greater than that caused by steam engines.

Maintenance methods have changed considerably in the last 10 years. It is not possible to separate the reasons for the change between those necessitated by heavy wheel loads and those which were necessary for reasons of economy. In any event today's timber bridge gangs are made up of fewer men equipped with more power tools and machines. It is felt that new tools are economically justified to keep pace with increased maintenance needs, since productivity can be increased with fewer men, and the work can be done in less time. This allows for scheduling more repair work with fewer men.

Some new materials have been found to be of benefit in maintaining timber bridges for today's loads. These include precast-concrete and steel components used in repairs, in-place treatment of deteriorated timber, and epoxy resin for use in posting and shimming piles.

In most instances timber that formerly was considered adequate for continued use in a bridge is now being reevaluated because of heavier loads. Many lines believe that in-place treatment of timber, which had shown signs of deterioration, has been of benefit in prolonging the useful life. This holds true only if the treatment is employed before the timber has lost enough structural strength to effect its carrying capacity. One road has inaugurated a program for the internal treatment of piling only, and has indicated that for an E-60 loading on a five-pile bent in a 30 ft high open-deck trestle, a 6-in void in a 14-in pile will not overstress it. They believe that in-place treatment is economically justified since the increased bearing stress due to this loss of 18.2% of area is still within design limits for compression both parallel and perpendicular to the grain. Another line concludes that a saving of from 200% to 400% is possible through the use of in-place treatment in ballast-deck trestles.

In general, the concensus of opinion is that heavier wheel loads are responsible for an increase in the crushing of caps and stringers. Several methods have been employed to combat this crushing. One of the most promising devices used to protect caps from piling is a rectangular steel plate slotted to accommodate the drift bolt, with a raised indented lug to keep the plate in place, which is placed between the pile and the cap. This plate distributes the load over a greater area of the cap so that compressive stresses perpendicular to the grain in the cap closely approximate those parallel to the grain in the pile.

Scabs may be bolted to both sides of the cap to provide additional bearing area for the stringers, which will help to combat crushing in both caps and stringers. It has been found helpful to use tighter bolt connections and more secure anchorage to reduce crushing as well as mechanical wear in bridge timber. Helper stringers have also been used successfully to better distribute the heavier loads in addition to assisting the regular stringers in carrying the loads.

On heavy-traffic main lines, one of the most frequent causes for tie renewals has been tie plate "cutting." This has become increasingly evident with increases in heavy wheel loads. Most roads believe that large tie plates and tie pads are of benefit in reducing wear in ties, and that in most instances the cost of large tie plates and tie pads plus the cost of installation is economically justified. It is evident that, when ties are being renewed on a bridge deck, the cost of applying larger plates and tie pads is very little more than the cost of reapplying the tie plates which had been removed. Many believe that an increase of only one year in the life of the tie would make this economically feasible.

Heavy load frequency has not changed the type of bent bracing, either transversely or longitudinally, and most roads have not had any noticeable increase in end-wise movement of stringers and ties in the last few years. It is believed that increased tractive and braking effort on longer trains may account for the few instances of end-wise movement. When this occurs, heavy application of rail anchors on trestle approaches, and adding longitudinal "hog-jaw" braces to the bridge, may be used to control the movement.

Most railroads have not employed any special maintenance procedures to cope with heavy wheel loads. Those lines which have adopted new methods for combatting the effects of increased loads have primarily gone to *a higher degree of inspection and maintenance.* This consists of more frequent inspections by better trained personnel giving special attention to line and surface, better scheduling of routine repairs, and prompt renewal of questionable members.

Undoubtedly, many of the most important questions with regard to the effects on timber trestles of increasingly heavy wheel loads have not been answered. It is felt that the subject is a complex one and that many years of study will be required to determine the actual effects of these loads. As new problems arise new methods will be employed to cope with them so that our developing technology of increasing wheel loads will result in a net benefit to our companies.

Installation and Maintenance of Tunnel Lining, and Increasing Clearances in Tunnels

Report of Committee

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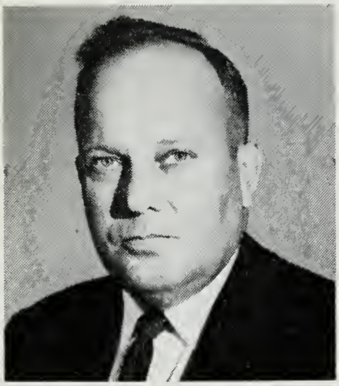
This committee was assigned the task of reporting on this subject with special consideration to be given to current trends and methods.



E. E. Runde
Chairman

Upon the adoption of new transportation techniques, such as the movement of two and three-deck auto racks, jumbo tank cars, trailers on flat cars and other higher, wider and longer shipments, it became obvious that tunnel clearances were becoming more and more critical.

It is also well known that most railroad tunnels are very old and that problems of maintenance have become increasingly severe. The passage of time brings deterioration in most tunnel linings, due to such factors as water, frost and chemical action, and many tunnels have been in service long enough to allow these agencies plenty of time in which to do their work.

Various railroads have solved the problem of restrictive clearances in a variety of ways. Line changes have been made, tunnels have been daylighted, lined tunnels have been enlarged and re-lined, tracks have been shifted and/or lowered and obstructions have been raised.

Problems of maintenance have also been solved in a number of ways.

This report is an attempt to acquaint you with some of the specific problems and methods used to solve them.

Installation of tunnel lining

The installation of any type of tunnel lining is costly, and considerable study is warranted to determine the type of lining most suitable for each particular case. In general, new tunnels today are lined with concrete or with steel plate. Each of these has its advantages and disadvantages and these should be gone into thoroughly before reaching a decision. There are many installations of each type throughout the country giving satisfactory results.

If a permanent lining is to be installed efficiently and economically, a detailed schedule of operations must be planned in advance and followed closely. The usual procedure is to begin the installation at the center of the section to be lined and progress in both directions to take advantage of the two working areas. The procedure at each working area should be scheduled to be as nearly independent of the other as possible. All phases of the operation should be programmed in time and manpower with the aim of installing a given lineal footage of completed tunnel lining each day.

In tunnels cut through unstable ground, it most generally will have been necessary to install a temporary lining of timber, or of steel ribs with timber lagging. Temporary lining in these cases is almost always installed with provision in horizontal and vertical dimensions for placing a permament lining inside of it.

In the case of concrete lining, it is imperative that the forms be so constructed that an entire section can be moved with a minimum of time and effort. This is sometimes accomplished by supporting the forms on jacks, which can be lowered to allow moving the form forward, and raised to position it for the next section. The length of the section will generally be determined by the volume of concrete that can be mixed, transported and placed in a given allotted time. The concrete is usually placed in the forms by means of a pumpcrete machine or by an air-placement machine. Either machine appears to work satisfactory. The use of additives in the concrete is common to improve the workability and in some instances an additive is used to accelerate the set so forms can be moved more quickly.

Sometimes the lining is concreted in one operation from floor to crown to floor; but more often it is placed in three operations, consisting of footing, sidewalls and arch ring. Either method should be satisfactory provided the concrete can be properly placed and compacted. Concrete lining is usually reinforced and will have a minimum thickness of 12 in. If no reinforcement is used, the minimum thickness is usually 18 in. to 24 in. This, of course, can be a disadvantage if it is necessary to increase the size of the bore to get the minimum thickness.

Steel plate lining may be of flanged corrugated plate placed in circumferential sections, or it may be of corrugated structural-plate with staggered circumferential seams. There appears to be no particular advantage of one over the other, except possibly where closeness to the natural rock will make structural-plate more difficult to bolt up. The void between steel-plate lining and natural tunnel roof and sidewalls must be filled as completely as possible in order that the lining will function properly. This is usually done by placing concrete or grout by means of a pumpcrete machine, air placer or grouter.

Assuming that a steel-plate liner is accepted as the equal of a concrete lining, insofar as strength and projected service life is concerned, it is usually a matter of economics as to which will be placed. This is generally determined by the cost of concrete or grout required to fill the void between natural rock and steel plate, as compared with the cost of the over-excavation required for a concrete lining. When a lining is to be installed under traffic, a steel lining has the advantage of not requiring a temporary minimum clearance since no forms are involved.

Lining a newly excavated tunnel, or one where traffic has been rerouted, allows the use of special techniques, and longer sections of lining can be placed. One of our southeastern roads recently lined a tunnel by means of a retractable form mounted on a standard 50-ft flat car. The form was fabricated in two sections, with a pivotal connection at the top, all supported on a frame work of tubular-steel scaffolding and timber bents. Horizontal and vertical adjustments were made by means of screw jacks. The car was blocked solidly from the tunnel floor to prevent settlement during the pouring operation.

This lining was placed in 50-ft sections and walls and arch ring were poured at the same time. Openings were provided in the sides of the form at 8 ft above floor line and at the spring line for inserting pumpcrete supply lines and vibrators, and for inspection.

Maintenance of unlined tunnels

Of first importance in the maintenance of unlined tunnels is proper inspection at frequent intervals. Every unlined tunnel should be inspected at least twice yearly, in the spring and in the fall. Once each year, preferably in the spring, every unlined tunnel should be inspected from an elevated position, such as a scaffold on push car, highway-railway truck or other such equipment. During this inspection, the roof and sides of the tunnel should be prodded and probed with scaling bars to remove all obviously loose rock, and areas of potential future trouble should be marked so that remedial measures may be taken.

One method used frequently to forestall future troubles from rock falls is installation of rock bolts. Conditions in individual tunnels will vary, but in general, rock bolts should be installed at 3-ft to 5-ft centers. The length should be determined by test drilling the area to be bolted to find the depth at which good anchorage in solid rock will be obtained. An examination of the rock strata in the approach cuts to the tunnel will give the approximate depth; but the final determination should be from close observation of the drilling, noting the location of bedding planes and thickness of the strata by the color of the cuttings and hardness of the drilling. The minimum length of bolt should be that which will insure having the anchorage at least one foot above a theoretical arch line, where the crown of the arch to spring line is roughly one-third of the span width.

As a matter of economy and efficiency, the drilling should be done with a stoper drill or jackhammer with air jackleg. The hole diameter will depend on the type of anchorage to be used and the hardness of the rock. It is recommended that a few test holes be drilled to determine the proper size hole before going into mass production.

Anchorage strength of rock bolts in different types of rock varies widely. A minimum of three tons anchor strength should be aimed for. There is a rule of thumb method for insuring this minimum strength, which is: Minimum anchor strength in pounds equals torque in foot-pounds times 50 plus or minus 1,000 lb. Thus, if 150 foot-pounds of torque is applied in tightening the rock bolt, the minimum anchor strength is 6,500 lb to 8,500 lb. Maximum anchor strength is obviously greater than this and this added strength may be considered a safety factor.

In 1950, one of our southeastern roads was faced with the problem of replacing a timber lining in a 2,600-ft tunnel bored thru a sandstone formation. The critical portion of the tunnel was 770 ft long and it was estimated that a concrete lining for this section, even at a very conservative cost of $400 per lineal foot, would cost approximately $300,000. In view of this, a test installation of roof bolts was made and it was determined that the bolts would safely support the roof and that the entire tunnel could be roof bolted for an estimated cost of $27,000.

Holes were drilled with a stoper drill mounted on a scaffold car equipped with roller bearing wheels that could be pulled with a motor car. This rig could drill a 1¼-in hole at approximately two feet per minute. The depth of the holes varied from 4 ft to 8 ft. When the desired depth was reached, 1-in slotted-end roof bolts were installed and 6-in by 6-in by ⅜-in plate washers and nuts were placed and tightened with an impact wrench. The exposed end was given an asphaltic protective coating. Bolts were installed generally at 4-ft centers, but closer if conditions required it. The installation was made 13 years ago. No maintenance has been required and recent inspection shows the roof to still be firm and solid.

Even though a tunnel may be cut through structurally sound rock, there will be bedding planes, crevices, faults, variation in depth of rock strata and isolated soft spots, and some rock on exposure to the air will flake, chip and spall. After the installation of rock bolts, as required, in such areas, welded wire mesh should be securely fastened to bridge the areas between bolts and shotcrete should then be placed. The shotcrete should be applied with the object of filling all cracks, crevices, and fissures to the end that natural arch action will be restored as nearly as possible. The shotcrete cannot be expected to add strength to the natural rock structure, but it will help to prevent loss of strength through the elimination of progressive rock falls. Areas of soft rock pockets and where fallouts have formed overhanging sidewalls, may be similarly repaired.

In the case of a tunnel where the roof slab is sound, but the sidewalls are subject to progressive fallouts which produce overhangs and wide spans, concrete support walls can be placed. These should be keyed into good rock at top and bottom and reinforced as a column. If the support wall is placed as a jacket on the natural rock, it should be anchored by installing expansion-type anchors drilled to a depth of at least feet or to solid rock.

Maintenance of tunnel lining

The six most common types of tunnel lining are timber, stone, brick, concrete, shotcrete and steel plate.

Linings of concrete, shotcrete and steel plate are of comparatively recent construction, and to date have not presented any particularly difficult maintenance problems. Therefore, this discussion will be limited to the maintenance of linings constructed of timber, stone and brick.

It can be stated in general that the condition of most lining is proportioned to its age, i.e., the older the lining, the poorer its condition. It is also generally true that the older the lining, the more scant is the available information of its details, particularly the extent of the voids behind it and the condition of the natural ground. Because of this general lack of information, no tunnel lining should be allowed to deteriorate to the point where major repairs or renewal are necessary.

Most timber lining was originally installed either as a temporary measure or for reasons of economy. Many tunnels, at the time they were excavated, required some type of temporary lining as a measure of protection against rock falls and cave-ins and timber was the material most readily available at the least cost. Such lining, in general, consists of heavy timber frames installed at 2-ft to 5-ft centers, lagged with smaller dimension timber or poles and backfilled with spalls. In those tunnels where timber lining is being maintained, it is usually a matter of replacement of individual bad timbers with new. Timber lining will generally deteriorate first at connection points and these should be given close and frequent inspection. All timber should be sounded for heart rot. To replace an entire length of timber which may be 20 ft or more long, because of rot or softening at the ends, is an expensive and tedious job.

About three years ago, one of our eastern railroads was faced with a problem of this nature in a 3,600 ft tunnel, of which 2,700 ft had been lined with untreated timber 13 years previously. Since replacement of the lining would have been a very expensive proposition, it was decided to try an in-place preservative treatment instead. This consisted of thoroughly soaking all exposed surfaces of the timber with a preservative and injecting the preservative under pressure into decayed areas through holes bored for the purpose. A complete and systematic inspection was made beforehand by sounding and by boring test holes. This treatment is expected to prolong the life of the timber 10 years or more.

One of our western roads reports that of its approximately 43 miles of tunnels, 16 miles were originally lined with timber which is progressively being replaced.

Where clearances and ground conditions will permit, short sections of timber are removed, movable steel forms are placed and concrete is pumped into place.

Where ground conditions will not permit complete removal of the timber, concrete ribs are constructed between timber frames. When this concrete has cured, the timber frames are removed and replaced with concrete.

Some lining has also been replaced by installing steel H-beam frames between timber sets, placing reinforcement and applying a minimum of 4 in of shotcrete.

This road reports that during the past two years 3,200 ft of timber lining has been removed and the natural tunnel roof shotcreted; and that 2,800 ft of timber lining has been replaced with steel bents and reinforced shotcrete.

Deterioration in lining constructed of stone and/or brick and the resulting maintenance repairs are very similar and will be discussed as one topic.

Some of the more common types of deterioration are fallouts from loss of mortar, bulging from uneven wall pressures, spalling from freeze-thaw action, erosion from stack blast and surface failure from age.

Fallouts from an arch ring can be replaced by relaying new brick or cut stone. But satisfactory results are almost impossible to obtain without using a supporting form, which is generally not practical because of clearances. A more common method is to install anchors, either expansion-type or those employing an explosive force, fasten ¼ in round rods and welded wire mesh and replace the fallout with shotcrete. By applying the shotcrete in layers approximately 1 in thick with a time lapse between, it is possible to build up as much as 8 in of shotcrete to replace two courses of brick or more in a relatively short time. An arch ring deteriorated from age and/or stack blast can be completely resurfaced in this manner. A prerequisite to the shotcreting is a thorough cleaning of the repair area by means of sandblast and waterblast and a thorough soaking. It also would be desirable in some cases to use a bonding agent.

Bulged sidewalls can be restrained from further movement by means of rock bolts. The installation procedures and techniques for this are the same as outlined in the discussion on maintenance of unlined tunnels, covered elsewhere in this report.

Many tunnel linings consist of a brick arch ring supported on rubble-stone bench walls. It is not uncommon for the bench walls to fail first. When this occurs, repairs can be made by replacing the stone support walls, either with concrete or shotcrete. The arch ring can be supported by removing stone masonry as necessary for the installation of vertical rails or H-beam posts at approximately 5 ft center to center. The posts should be capped at top and bottom with steel plates, and firm bearing may be obtained by driving steel wedges or by the use of quick-setting mortar. When all posts are in place, the remaining poor stone masonry may be removed and anchors and reinforcement may be placed. The choice of concrete or shotcrete for these repairs will usually be determined by the size and depth of the repair area and the limitations as to side clearance.

Increasing clearances

Three general methods have been used to obtain increased clearances in tunnels. These are: (1) Lowering track, (2) day-lighting, and (3) enlargement.

The method used is usually determined by factors peculiar to each particular tunnel. Each method will be discussed as a separate topic.

Lowering track

More roads have improved overhead clearances in tunnels by lowering track than by any other method, because it is the most economical by far and generally is the surest and safest way. This is true, even in those cases where a solid rock floor is encountered.

When advance exploration indicates that a solid rock floor must be lowered, it has been common practice to re-route traffic, remove the track and conduct the entire track-lowering operation on an around-the-clock basis.

The preliminary exploration, of course, must be complete enough to determine the best way of lowering the floor. It may require drilling and blasting; or a ripper might be necessary or it might require only an end loader with teeth. Which method is to be used must be determined in advance so arrangements can be made to have the proper equipment on hand and to calculate the time the track will be out of service.

If the tunnel has a lining, investigation must be made to determine if the new tunnel floor will be below the base of the lining and, if so, what steps are necessary to protect it.

One road lowered the floor of a 1,330-ft brick-lined tunnel 26 in. in 8 days, working three shifts. Two months of preliminary work under traffic was necessary in construction of concrete curb walls to protect the base of the lining. When the track was taken out of service, the rails were laid along the sides, ties were bundled and removed, rippers were used to loosen the old ballast and tear up the sandstone rock floor to the required depth, and end loaders were used to load the excavated rock and ballast. On completion of the lowering operation, concrete struts were constructed at 12-ft intervals to act as spreaders between the curb walls; new ties were laid in the tunnel and good secondhand ties in the approaches; and the rail was relaid and new ballast placed. The work was accomplished and traffic restored in 8 days at a cost of approximately $117 per lineal foot of tunnel.

The track in many tunnels has been lowered by merely removing excess ballast that has accumulated through the years. The work is usually done with cribbing machines and an undercutter.

Advance preparation consists of stripping the cribs and excavating a ditch at the end of the ties to receive the undercuttings. Undercutting is then carried out by a continuous chain carrying digging and clearing tools which move in a guide at high speed under the ties at right angles to the center line of track and sweep the dirt and ballast into the previously excavated ditch where it is picked up and loaded. An undercutter will remove 3 in to 6 in or more of old ballast in one pass, depending on how badly it is cemented together. The machine can be uncoupled to clear for traffic in a few minutes.

Undercutting leaves a smooth, unballasted roadbed which, with proper run-off, can be operated over immediately under a slow order. Average progress appears to be 400 ft to 600 ft per hour for each pass. One road reports an average cost of $5.07 per cubic yard for undercutting and removing 28 in of ballast in a tunnel.

Day lighting

Daylighting, or open cutting, is the most desirable way of improving tunnel clearances, but unfortunately it is practical only under special conditions and is usually more expensive than lowering track. Modern equipment for moving earth and rock and new techniques of blasting have been the principal factors conducive to daylighting.

In giving consideration to open cutting a tunnel, the depth and type of over-burden are critical factors. Some roads have found that the unit cost of excavation remains the same for widely variant types of material from common earth through soft sandstone, with a moderate increase in unit cost for excavation of the class of soft through medium sandstone, and a sharp increase when the excavation is to be hard rock. The total cost of excavation will be determined by its volume. Therefore, the slopes of the excavation become increasingly important, because they determine the volume.

The most common method of determining the slopes suited to a particular cut is by examination of similar cuts through the same type of material, either in the approach cuts to the tunnel or in highway approach cuts nearby. If such a cut has stood for as little as five years without developing slides, it is safe to assume that it will stand so for many more years.

The trend recently in open cutting leans toward almost vertical faces with rather narrow benches at changes in rock strata.

Over-break and shattering can be reduced to a minimum by the pre-split method of blasting which has been used successfully for the excavation of some very deep cuts at costs commensuate with tunneling. In most cases, this method of blasting produces a clean, smooth rock face requiring only a minimum of scaling for many years. Pre-splitting requires special techniques and a thorough knowledge of blasting and should not be attempted by an amateur. Most manufacturers of explosives will be glad to offer their services and recommend a blasting technician.

Many tunnels with overburden of 100 ft or less have been daylighted using standard earthmoving equipment. One such tunnel in the south, constructed in 1860, consisted of a circular five-course brick barrel installed through a soft sandstone formation. The contractor who did the job on a unit price basis elected to use bulldozers, scrapers and a ripper to remove the overburden down to the brick barrel, and when this had been done for the 426 ft length of tunnel, traffic was re-routed for approximately 28 hours while the brick was blasted down and removed. The work involved the removal of approximately 63,000 cu yd of earth, rock and brick lining for a unit cost of approximately $1.50 per cu yd.

Enlargement

The enlargement of tunnels as a means of improving clearances is usually undertaken as a last resort, after it has been determined that neither lowering the track nor daylighting is feasible, inasmuch as it is the most expensive, involves the most uncertainties, and requires the most time.

Unlined tunnels do not present any particular difficulties to enlargement, but a study should be made of the rock strata to insure that the enlargement will not expose a poor grade of rock that will cause future troubles. It is sometimes advisable to secure the services of a geologist or local mining expert to determine this.

Lined tunnels present the most difficulties to enlargement, primarily because of the uncertainty as to what conditions are behind the lining, and as to what will be required in the way of temporary lining and new permanent lining.

Most old tunnel lining consists of brick or stone masonry or timber and was backfilled when constructed to fill the void between it and the natural rock line. The extent of the void is usually very indefinite. Preliminary explorations should be made by cutting holes through the lining and the information obtained in this manner will be very helpful, but true conditions will not be known until the actual removal is begun. The best policy is to prepare in advance for the worst and hope for the best.

Various methods have been used in the removal of old lining. One road faced with enlarging a lined tunnel under traffic found that the longest working period in any one day was quite often as little as one hour and never more than three hours. This, of course, hardly left time to place the explosives and set them off, much less clear the debris for passage of trains, so two methods were devised whereby it would be necessary to spend only a minimum of time clearing for traffic after blasting.

For the removal of brick arch ring and rubble stone fill above it, a low-side steel gondola was fitted with timber sideboards that could be laid out against the sides of the tunnel when the car was in position and blocked. The brick lining was then blasted loose, four lineal feet at a time, and allowed to fall directly into the car. When the dust cleared and the explosives technician gave the all clear, the sideboards were removed and the tunnel could be cleared for passage of trains in a matter of minutes.

In the removal of natural rock from the roof, the size of rock slabs blasted loose could not be predicted and, in order to damage the car as little as possible, a standard flat car was floored solid with 7-in by 16-in stringers on edge crossways of the car, and cut to a length that would just clear the sides of the tunnel. A stringer was also fastened along each edge to act as a sideboard. After the car was positioned and blocked, the natural rock was blasted loose and allowed to fall directly onto this car. It was later transferred to a gondola for shipment or unloaded to widen embankment with a crane and clamshell bucket.

The particular enlargement project involved a tunnel 850 ft long, of which approximately 230 ft were lined with a three-course brick arch ring on rubble-stone benchwalls. Approximately 1,200 cu yd of old lining and rubble fill were removed for an average cost of $15.00 per cu yd. Approximately 415 cu yd of solid rock were removed from the roof and sidewalls at an average cost of $38.00 per cu yd.

This enlargement also included construction of 260 cu yd of concrete in support walls and a portal, installation of 400 roof bolts and approximately 10,400 sq ft of shotcrete work. The overall project cost was $113,000 for an average cost of $133.00 per lineal foot. The tunnel was enlarged to a minimum overhead clearance of 20 ft 0 in. The enlargement required 100 working days to complete. An average of 3 hours out of every 8 was lost, due to clearing trains.

Inasmuch as there were private business establishments located only 100 ft from one portal of the tunnel, and private residences on the top of the hill through which the tunnel was bored, 150 ft above the track, which could have been damaged during blasting operations, it was thought advisable to carry public liability and property damage insurance in the amounts of $250,000/1,000,000 and $250,000/500,000. The total premium cost of this insurance coverage for the entire enlargement was $12,500 or approximately 11% of the project cost.

Conclusions

In the analysis of information gathered in connection with the preparation of this report, one fact has been brought out quite clearly. There is no standard criterion to follow, insofar as the installation and maintenance of tunnel lining and increasing clearances in tunnels, is concerned.

It is apparent that each railroad has analyzed its tunnel problems on an individual tunnel basis, with no attempt at uniformity in either methods or working dimensions.

Maintenance—work in tunnels is very expensive and warrants a considerable amount of advance study and planning to insure that the repairs to be made are adequate and long lasting and do not reduce clearances.

Extensive clearance improvement programs on main-line districts of many railroads have resulted in new overhead clearances varying between 17 ft 6 in and 20 ft 0 in. Very few have resulted in standard overhead clearance of 22 ft 0 in. From this, the assumption can be made that most railroads have overhead obstructions that cannot be changed without very great expenditures which cannot be justified at this time or at any time soon.

Modern Heating, Insulating and Ventilating Methods for Railway Buildings

Report of Committee

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Heating of railway buildings is as old as the railways themselves, but today we find it necessary to install more sophisticated systems of heating, air conditioning, ventilating and insulating to satisfy modern man and machines.

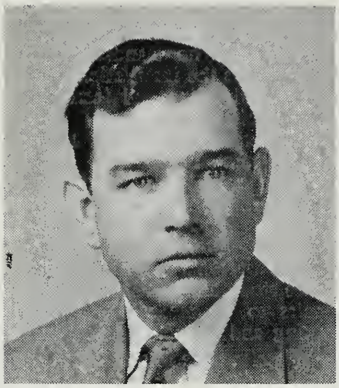
Great strides have been made from the pot belly stove to the modern heating-air conditioning-ventilating systems that provide constant temperature, humidity control and filtration of air.

We can only deal with the major advances in this vast field in this report.

HEATING

High-pressure steam still has its applications in heating of railway buildings, although it is not as popular as it formerly was when it was necessary to maintain large power plants at steam-locomotive engine terminals.

High-pressure steam is more suited for larger shop heating and where long runs are necessary. It is usually used in blast heaters or unit heaters. High-pressure steam is not suitable for radiation in offices. It should be reduced for use in radiators by use of a reducing valve.



C. F. Foster
Chairman

High-pressure steam may be produced by water tube, horizontal return tube, scotch marine, fire tube, or flash boilers. During the past decade there have been improvements in the development of the packaged unit boiler, in the range of 10 to 600 hp in the fire-tube type, and larger sizes in the water-tube type. These boilers have become very popular as they come equipped with burners and all necessary controls installed at the factory. This provides a more economical and faster installation and places the responsibility on one manufacturer. Flash-type boilers, similar to diesel-locomotive boilers, have been used to generate steam for building heating. These are complicated boilers and must be provided with the proper water treatment and maintenance. The coils are prone to burn out unless frequently washed out.

Many improvements have been made in electric boiler-feed pumps, water make-up systems and deaerators.

It is often possible to modernize high-pressure steam systems, and at the same time reduce operating expenses by installation of automatic-gas or oil-fired burners.

With the introduction of motorized valves, with thermostatic controls it is possible to zone a steam system so that different temperatures may be maintained in various areas. This will reduce the overheating that was common in older systems, and thus reduce operating casts.

The proper water treatment and air elimination is of the utmost importance in reducing maintenance of steam-heating systems, and especially in preventing failure of return lines.

Some railroads have found that the copper-tube finned coils in blast heaters and unit heaters have corroded and failed within a matter of a few years when installed in existing systems with improper water treatment. The older type cast-iron cores in blast or unit heaters have longer life when exposed to poor water conditions.

Low-pressure steam

Low-pressure (15 psi or less) steam is suitable for small and medium sized buildings. It is not being used on new installations to the extent that it was in former years.

The improvements made in low-pressure systems during recent years consist principally of conversion to automatic firing with gas or oil, thus eliminating the fireman and coal and ash handling. Many years of satisfactory service can be gained from these existing systems by this type of conversion. Automatic firing requires thermostatic controls and, in some cases, zone controls. These provide a more even heat, reduce over-heating and thus provide lower fuel costs. One railroad reports that heating costs were reduced from $2000 per year to $1200 per year upon the installation of a gas-fired boiler and four thermostatically controlled zones.

Packaged unit steam boilers are successfully used for larger installations. Cast-iron sectional, or steel boilers are suitable for smaller heating systems.

Copper-tube finned radiation is being promoted by the manufacturers rather than cast-iron radiation because of its better appearance and light weight. However, cast iron holds heat longer for more even heating, and is not as subject to corrosion.

Water treatment in the small closed low-pressure system is not as great a problem as in large high-pressure systems.

Hot water—Gravity

Gravity hot-water heating systems are no longer being installed. They can be modernized by installation of automatic firing, thermostatic control, and booster pumps.

Hot water—Forced

Forced hot-water heating systems have been developed for small one-zone systems to large multi-zone systems during the past few years. They have proved to be a very satisfactory method for building heating, and have supplanted steam in many new buildings.

Many types of boilers such as cast-iron sectional, steel, and packaged units may be used. A wide variety of pumps, fittings and controls are available.

Blast heaters, unit heaters, convectors, radiators, and baseboard units of finned tube or cast iron all may be used with forced hot-water systems. This provides the designer with a wide choice of heating methods.

The piping may be done in a number of ways from the simple one-pipe loop to complicated multi-zone systems with supply and return pipes.

Due to the system being closed there is a minimum amount of make-up water, and water treatment may often be omitted in the smaller systems.

Hot air—Furnace and duct systems

These systems are suitable for the small installation using a complete furnace unit with built in blower of sizes up to 200,000 Btu's to larger furnace systems with separate blowers. These systems can also use the same fan and ductwork for air conditioning.

Gravity systems are no longer being installed, being superseded by furnaces with blower fans.

Since the advent of the basementless buildings, reverse-flow furnaces have been developed with the perimeter duct system located beneath the floor and with registers usually under the windows.

Several railroads have used this type of heating system for heating small buildings.

During the past few years gas-fired duct furnaces have been developed that can be fitted into a duct, and hung overhead, thus not using valuable floor space. They also are being used in connection with air-conditioning systems to provide heating in the air-conditioning ductwork in winter, and re-heating cooled air in summer for zone or humidity control.

Hot air—Direct-fired units

The simplest direct-fired units are the oil or gas-fired floor-mounted space heaters or suspended unit heaters. They are available in a wide range of sizes. These units have supplanted the old coal stove at most locations as they do not require attention and are cleaner. They can be utilized most economically in small stations, section tool houses, yard offices and welfare buildings where it is necessary to keep plumbing from freezing when buildings are unattended for several days.

Wall furnaces are suitable also for the small structure. They are available in sizes from 28,000 to 65,000 Btu's and are equipped with blowers capable of moving from 150 to 200 cfm of warm air. They can be single-wall units or double units for heating two rooms.

Direct-fired, gas or oil units with blower fans and automatic controls are available in a range of sizes from 200,000 Btu's to over 3 million Btu's. They may be obtained in floor-mounted, inverted, overhead and other types. They are useful where large areas such as enginehouses, shops and storerooms are to be heated. Units may be connected to ducts if desired.

A recent development is the direct gas-fired make-up air unit. The products of combustion are discharged into the air stream. These units are available in sizes from 2,500 cfm to 150,000 cfm. They are suitable for diesel shops or other buildings where large quantities of make-up air are required.

Electric

The electric power industry has recently been vigorously promoting the use of electric heating and have been offering special heating rates. Generally the rates are such that electric heating costs are two to three times more than other fuels, except in areas such as TVA where there are very low rates. Electric heat has some advantages such as cleanliness, low maintenance and economical installation.

Electric heating may be produced by electric unit heaters, convectors, base-board units and by resistor wires embedded in concrete floor or plaster ceiling.

One railroad is using electric heat in the waiting rooms of several brick suburban stations. The electric heating cable is embedded in the concrete floor. Thermostats set for 50 to 60 degrees provides adequate heating. This type of heating was selected because there would be no heating units visible that could be damaged by vandals, and it was felt that the extra operating costs of electric heat would not be prohibitively high.

Electric-compressor heat pumps have been used in small yard offices and other small office buildings. These units are automatic, converting from heat to cooling as the temperature varies. They can be equipped with an electric booster heating coil to supplement the heating capacity of the compressor in cold weather.

Infra-red

This type heating has been found to be most effective in heating large shops and other buildings with high ceilings and poor insulation. The advantages of this form of heating have been known for a long time but until recently there has been no practical equipment for this type.

Infra-red waves act like light, traveling in straight lines at 186,000 miles per second. When these waves strike an object some are reflected the same as light is reflected by a mirror. Some materials may allow a portion of the waves to pass through just as light is transmitted through glass. The infra-red radiation is absorbed and converted into heat. While all warm objects give off intra-red rays, the temperature of ordinary steam or hot-water heaters is so low that the portion of their output transmitted by radiation is small and like warm-air systems and unit heaters, they depend primarily on the movement of heated air for their effectiveness. Where it is not possible to confine or direct the heated air, infra-red systems will give better performance at a lower operating cost.

There are several types of infra-red heaters available, each of which has specific areas of application. High-temperature electric infra-red heaters provide concentrated heat for processing and heating applications. Gas-fired infra-red generators are units incorporating the use of natural, manufactured, or propane gas. They give off long wave infra-red radiation that heats the object that it strikes. One railroad made studies comparing conventional steam unit heaters, using oil or coal to provide heat for steam, with the gas-fired infra-red units. The infra-red units provided the effective heating required for 60% of the calculated cost of steam unit heaters. The infra-red heaters may be spaced to heat an area uniformly, to heat limited portions of an area or to provide spot heating.

A glass company has just announced a glass radiant heater for installation in a standard grid-suspended ceiling and especially engineered for use in offices and isolated industrial work areas. This panel emits long wave infra-red radiation and is made of borosilicate glass into which a thin metallic oxide film has been fired to conduct electricity and to produce the infra-red rays.

AIR CONDITIONING

Air conditioning in railroad buildings is in greater demand than ever, not only for the comfort of employees, but also for controlling temperature and humidity conditions where data-processing systems are used.

Air conditioning has come to be regarded as a necessity and to find proof to justify the expense of air conditioning and its effect on efficiency, the General Services Administration conducted tests where personnel worked under the same conditions with the exception of air conditioning in the test area.

The "Control" space was heated by direct radiation from radiators under the windows. Ventilation depended on opening the windows. Air conditioning installed for the test area was operated to hold a uniform temperature of 75 degrees F, plus or minus 2 degrees, and a relative humidity not exceeding 50%. The testing period covering the five months from May through September. The results for the test period show that average work production increased 9.5% in the air-conditioned test area. Absenteeism in non-air-conditioned space was 2.5% higher and there was 0.9% increase in errors per person per month in the control area.

In most installations the increase in productivity will be more than enough to pay for air conditioning.

There are many types of air conditioning systems in use, each of which has its advantages for certain applications.

The one and two-ton packaged window units are most suitable for private offices and other small offices. Their maintenance cost is often high.

The larger air or water-cooled packaged units of 5 to 10 tons capacity are suitable for medium sized rooms. These units may be installed with or without ductwork. Ductwork with diffusers provides better air distribution.

Direct-expansion air-conditioning units with air-cooled compressors or water towers are available in medium and large sizes. One or more blower fans are provided with a system of ducts and diffusers. The cooling coils are mounted in the ducts. Roof mounted units are useful in many installations.

Several types of water chillers are available. The chilled water can be pumped to the air handling units, even at remote locations. A water tower is generally used with the water chillers. With the use of a number of air handling units with dampers, bypass valves and controls the system can provide good zone control for large areas or small private offices. One variation of this system uses two sets of ducts, the cold duct and the hot duct. The cold and hot air are mixed together in mixing boxes and then introduced to the room in diffusers or thru lighting fixtures. Each mixing box can be controlled by a thermostat. This system provides individual temperature control for private offices or different areas of the same room that may have different cooling requirements due to exposure, office machines or other heat sources.

An interesting new development is the technique which combines fluorescent lighting fixtures with air supply and exhaust diffusers. One system uses ordinary diffusers for supply air and exhaust through the lighting fixtures. Another system uses some of the lighting fixtures for supply and others for exhaust.

Another new development is the radiant metal-pan ceiling. This ceiling not only provides radiant cooling to remove heat from the lighting fixtures at the point where heat is generated, but also offers radiant cooling to offset outdor heat gains, radiant heating, and acoustic control. Finned-tube coils for hot or chilled water are placed above the metal-pan ceiling. A sound absorbing insulating blanket is placed above the coils.

To give cost information on air-conditioning installations, the accompanying list begins with the simplest type of summer air-conditioning and progresses through the various simpler package installations to more involved systems. Items 1 through 4 are for buildings that are heated by separate systems. Items 5 through 10 describe systems where summer and winter air-conditioning are involved.

The operating cost of air-conditioning systems varies considerably and will depend on the size, hours of operation, type, and maintenance cost, but usually the operating cost of small installations (under 50 tons) requiring a minimum of labor and with no engineer in attendance should not exceed $25 per ton per year or 10 cents per sq ft based on 250 sq ft per ton. On larger installations where licensed refrigeration engineers and maintenance mechanics during operating hours are required, the cost will be 14 cents to 26 cents per sq ft per ton per year or $35 to $65 per ton per year. An average cost can be taken conservatively as 20 cents per sq ft per ton per year for operations.

VENTILATION

Older structures usually were adequately ventilated by open windows and doors and

Types of air-conditioning installations

Type of installation	Floor Area Air Cond. sq. ft.	Tons	Tons Per 100 sq. ft.	Cost Per Ton	Cost Per sq. ft.
1 Window Units					
(a) Division office—Ga.	11,900				$0.88
(b) Division office—Fla.	3,430				1.01
2 Package unit in Air Cond. space with remote air-cooled condenser —No duct work					
(a) Yard office—Fla.	940	5	.26	$ 444	2.37
(b) Ticket office—Ala.	640	3	.47	470	2.21
3 Fan-coil unit in air-cond. space with remote air-cooled condensing unit. Exposed duct work.					
(a) Freight depot offices, S.C.	1,009	4	.40	420	1.66
(b) Yard office, Ga.	1,870	7½	.40	417	1.67
4 Package unit external to air-conditioned space with remote water tower—concealed duct work					
Freight whse. office, Fla.	3,600	10	.28	569	1.58
5 Package unit external to air-conditioned space with remote air-cooled condenser. Concealed duct work with gas-fired duct furnace					
Freight depot offices, N.C.	3,200	10	.31	706	2.19
6 Package unit external to air-conditioned space with remote air-cooled condenser. Concealed duct work hot-water coil and cast-iron boiler					
Freight whse. offices—Ala.	2,520	10	.40	772	3.05
7 Built-up system with concealed duct work. Package chiller with air-cooled condenser and zoned fan-coil unit with chilled-water coil using shop steam. Pneumatic controls.					
Passenger sta.—Ga.	6,975	21	.30	1198	3.39
8 Built-up system with concealed duct work. Package chiller with water tower and fan-coil unit for general office and console units for private offices. Hot water from C.I. boiler piped for summer-winter tempered water control to common coil.					
Freight depot offices—Fla.	4,900	12	.25	1145	2.81
9 Built-up system with concealed duct work. Direct-expansion compressor with water tower. Zoned fan-coil unit with direct-expansion cooling and low-pressure steam coil using shop steam.					
Division office building—Fla.	28,350	70	.25	720	1.78
10 Built-up heat-pump system with concealed duct work. Direct-expansion compressor with reverse cycle controls for air to air heat-cool operation.					
Passenger station—Fla.	4,150	12	.29	1230	3.55

Note: (1) Costs shown do not include electrical installations beyond simple connections of equipment to building panels and necessary control wiring.

(2) All costs have been adjusted to present time by application of Engineering-News Record Building cost indices. (ENR 604 March, 1964)

by the cracks around same. In the modern tight building it is likely that some form of gravity or mechanical ventilation may be necessary. Ventilation may be provided by supply, exhaust or a combination. In new structures this is generally done by power fans rather than with gravity ventilators. During cold weather supply air must be tempered before introduction into the building.

Shop buildings where heat or fumes are generated by certain equipment should be provided with adequate exhaust ventilation. Diesel shops present a challenging problem in ventilation.

INSULATION

Insulation of buildings has become more important with the advent of air-conditioning and modern heating systems. Properly installed insulation will help to keep construction and operating costs at a reasonable level.

In addition to the older proven types of insulating materials, such as rock wool and Fiberglass, polystyrene and urethane have recently become commercially available. Urethane possesses a heat transmission rate of .15 to 75 degrees as compared to polystyrene of .26, cork .28 and Fiber of .23. Polystyrene is less expensive for equivalent insulating value than urethane, but urethane has better heat resistance qualities. Urethane may be pre-moulded, foamed or sprayed.

The trend for average size railroad structures is toward the prefabricated-metal building which must be well insulated. A minimum of 3 in. is recommended.

Insulated buildings, steel buildings especially, must be well sealed with a vapor barrier. Warm moist air from the building interior can easily condense on the interior surfaces of the outside wall or roof material. In the wall this is not serious as the usual procedure is to have holes at the bottom to allow breathing in the air space. Under a roof such moisture may fall into the insulation and decrease its value as an insulating material, unless the ceiling has a good vapor barrier.

A steel-panel roof uninsulated is improved from a "U" factor of .63 to .46 by the addition of an aluminum coating over the zinc coating. This is due to the reflectivity of the aluminum coating.

In order to reduce infiltration losses from cracks in older structures it may be advisable to replace old doors with over-head-type doors or rolling-steel doors. Rolling-steel doors should be provided with weather stripping and windlocks. Deteriorated window sash may be replaced with corrugated Fiberglass panels. They should be tightly sealed at edges. Storm windows should be applied on a well insulated building.

Although not an insulation as we normally think of it, venetian blinds, lined draperies, sun shades, solar controls, insulated and tinted glass also have an effect in reducing cooling costs.

Money spent for insulation and construcion is spent only once, while heating and cooling lasts throughout the building life. A well insulated building generally will save heating and air-conditioning operating expenses in excess of insulation cost.

While the modern methods of heating, air-conditioning and ventilating provide superior working conditions to older systems, and in some cases are more economical, they do create problems in that their satisfactory operation depends on proper functioning of complicated electronic controls. A failure in electronic controls often can shut down the entire system. These systems require competent maintenance personnel and a periodic maintenance schedule. The proper training of railway maintenance personnel in the operation and maintenance of these systems can save costly repairs and service charges from local contractors.

HISTORICAL INFORMATION

List of Annual Conventions

No.	Place of Meeting	Date	Membership
1	St. Louis, Mo.	Sept. 25, 1891	60
2	Cincinnati, Ohio	Oct. 18-19, 1892	112
3	Philadelphia, Pa.	Oct. 17-19, 1893	128
4	Kansas City, Mo.	Oct. 16-18, 1894	115
5	New Orleans, La.	Oct. 15-16, 1895	122
6	Chicago, Ill.	Oct. 20-22, 1896	140
7	Denver, Colo.	Oct. 19-21, 1897	127
8	Richmond, Va.	Oct. 18-19, 1898	148

No.	Place of Meeting	Date	Membership
9	Detroit, Mich.	Oct. 17-19, 1899	148
10	St. Louis, Mo.	Oct. 16-18, 1900	143
11	Atlanta, Ga.	Oct. 15-17, 1901	171
12	Minneapolis, Minn.	Oct. 21-23, 1902	195
13	Quebec, Canada	Oct. 20-22, 1903	223
14	Chicago, Ill.	Oct. 18-20, 1904	293
15	Pittsburgh, Pa.	Oct. 17-19, 1905	313
16	Boston, Mass.	Oct. 16-18, 1906	340
17	Milwaukee, Wis.	Oct. 15-17, 1907	341
18	Washington, D. C.	Oct. 20-22, 1908	368
19	Jacksonville, Fla.	Oct. 19-21, 1909	393
20	Denver, Colo.	Oct. 18-20, 1910	428
21	St. Louis, Mo.	Oct. 17-19, 1911	499
22	Baltimore, Md.	Oct. 15-17, 1912	524
23	Montreal, Quebec	Oct. 21-23, 1913	570
24	Los Angeles, Cal.	Oct. 20-22, 1914	586
25	Detroit, Mich.	Oct. 19-21, 1915	665
26	New Orleans, La.	Oct. 17-19, 1916	710
27	Chicago, Ill.	Oct. 16-18, 1917	704
28	Chicago, Ill.	Oct. 15-17, 1918	716
29	Cleveland, Ohio	Oct. 21-23, 1919	776
30	Atlanta, Ga.	Oct. 26-28, 1920	840
31	New York, N.Y.	Oct. 18-20, 1921	850
32	Cincinnati, Ohio	Oct. 17-19, 1922	865
33	Seattle, Wash.	Oct. 16-18, 1923	846
34	Kansas City, Mo.	Oct. 21-23, 1924	837
35	Buffalo, N.Y.	Oct. 20-22, 1925	759
36	Richmond, Va.	Oct. 12-14, 1926	750
37	Minneapolis, Minn.	Oct. 18-20, 1927	754
38	Boston, Mass.	Oct. 23-25, 1928	755
39	New Orleans, La.	Oct. 15-17, 1929	755
40	Louisville, Ky.	Oct. 21-23, 1930	713
41	Chicago, Ill.	Oct. 16-18, 1934	592
42	Chicago, Ill.	Oct. 15-17, 1935	547
43	Chicago, Ill.	Oct. 20-22, 1936	588
44	Chicago, Ill.	Oct. 19-21, 1937	566
45	Chicago, Ill.	Oct. 18-20, 1938	589
46	Chicago, Ill.	Oct. 17-19, 1939	546
47	Chicago, Ill.	Oct. 15-17, 1940	610
48	Chicago, Ill.	Oct. 14-16, 1941	594
49	Chicago, Ill.	Oct. 20-22, 1942	618
50	Chicago, Ill.	Oct. 20-21, 1943	597
51	Chicago, Ill.	Sept. 17-19, 1946	698
52	Chicago, Ill.	Sept. 16-18, 1947	651
53	Chicago, Ill.	Sept. 20-22, 1948	652
54	Chicago, Ill.	Sept. 12-14, 1949	676
55	Chicago, Ill.	Sept. 18-20, 1950	713
56	Chicago, Ill.	Sept. 17-19, 1951	676
57	Chicago, Ill.	Sept. 15-17, 1952	667
58	Chicago, Ill.	Sept. 15-17, 1953	666
59	Chicago, Ill.	Sept. 13-15, 1954	682
60	Chicago, Ill.	Sept. 19-21, 1955	625
61	Chicago, Ill.	Sept. 18-20, 1956	657
62	Chicago, Ill.	Sept. 23-25, 1957	769
63	Chicago, Ill.	Sept. 15-17, 1958	828
64	Chicago, Ill.	Sept. 15-17, 1959	863
65	Chicago, Ill.	Sept. 19-21, 1960	932
66	Chicago, Ill.	Sept. 18-20, 1961	968
67	Chicago, Ill.	Sept. 10-12, 1962	942
68	Chicago, Ill.	Oct. 14-16, 1963	887
69	Chicago, Ill.	Sept. 14-16, 1964	860

PAST OFFICERS

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. F. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Jonhston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCoy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	....	....	F. O. Whiteman	A. G. Shaver
Treasurer	....	....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

†To November 1, 1942
‡To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. A. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. von Sprecken
	H. D. Curie	E. R. Schlaf	T. M. von Sprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963	1963-1964		
President	J. M. Lowry	E. R. Schlaf		
1st V.-Pres.	E. R. Schlaf	R. C. Baker		
2nd V.-Pres.	H. A. Matthews	Shirley White		
3rd V.-Pres.	R. C. Baker	H. M. Wilson		
Secretary	Ruth Weggeberg	Ruth Weggeberg		
Treasurer	L. C. Winkelhaus	E. F. Snyder		
Directors	Shirley White	R. D. Hellweg		
	H. M. Wilson	F. W. Hutcheson		
	R. D. Hellweg	W. F. Armstrong		
	F. W. Hutcheson	J. W. DeValle		
	W. F. Armstrong	J. A. Goforth		
	J. W. DeValle	E. R. Simmons		

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2.** A member shall be a person in a position above rank of gang foreman in connection with roadway bridge, building and water service work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least 15†† years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

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*Amended October 16, 1941.

**Amended September 20, 1948.

††Amended March 10, 1958.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9.** Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1†. The officers of this association shall be a president, three vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

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*Amended October 16, 1941.

**Amended September 20, 1948.

†Amended September 21, 1957.

Section 2‡. The president, three vice-presidents, secretary and treasurer shall hold office for one year and the directors for three years, two directors being elected each year. All officers retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

Section 2.‡ A person stricken from the list of members because of non-payment of dues, upon written application may be reinstated as a member in his former class without loss of privileges, either upon payment of all back dues (which must accompany application) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2, Article III.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

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†Amended October 17, 1940.
*Article adopted 1922.
**Amended September 20, 1948.
‡Amended September 21, 1957.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

**DUES

5. The annual dues, for the fiscal year ending August 31, and payable in advance, shall be as follows:*

Members, $7.00; Associate Members, $7.00; Junior Members, $5.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.♯ After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

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†Amended October 17, 1940.

‡Adopted October 17, 1940.

*Amended June 22, 1964.

**Amended September 20, 1948.

♯Amended December 4, 1950.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

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†Amended September 20, 1948.

DIRECTORY OF MEMBERS

as of December 1, 1964

(Figure after each name indicates year when member joined the Association)

* Indicates Junior Member

HONORARY MEMBERS

Barnhart, E. H., (Ret.) Div. Engr., B. & O., St. Petersburg, Fla. (1941)

Howard, N. D., (Ret.) Exec. Secy., A.R. E.A., Evanston, Ill. (1926)

Strate, T. H., (Ret.) Div. Engr., C. M. St. P. & P., San Ysidro, Calif. (1918)

Vandenburgh, E. C., (Ret.) Ch. Engr., C. & N. W., Chicago, Ill. (1925)

Winkelhaus, L. C., (Ret.) Arch. Engr., C. & N. W., Chicago, Ill. (1934)

ACTIVE MEMBERS

A

Adams, J. H., Jr., Bldg. Engr.-Sys., C. & O., Huntington, W. Va. (1961)

Ahouse, F. B., Jr., Supvr. B. & B., G. & F., August, Ga. (1964)

Albert, E. A., Supvr. B. & B., I. C., Champaign, Ill. (1964)

Alderson, A. D., Asst. Ch. Engr. Br. & Struct., S. L., Minneapolis, Minn. (1961)

Alexander, M. B., Supvr. Struct., B. & L. E., Greenville, Pa. (1961)

Allen, J. P., Engr. Brdgs., Sou., Knoxville, Tenn. (1963)

Allen, W. V., Supvr. B. & B., C. & O., Huntington, W. Va. (1959)

Alley, F. T., Asst. B. & B. Supv., St. L. S. W., Tyler, Tex. (1955)

Almendrales, G., Design & Detailer-Brdg. Dept., C. M. St. P. & P., Chicago, Ill. (1964)

Anderson, M. P., Ch. Engr., Monon, Lafayette, Ind. (1959)

Anthony, O. D., Civil Engr., B. & A., Houlton, Me. (1962)

Armstrong, W. F., Engr. Bldgs., C. & N. W., Chicago, Ill. (1947)

Arnold, L. K., Asst. Gen. Fore. B. & B.-W. S., A. T. & S. F., San Bernardino, Calif. (1963)

Arrington, R., Arch. Designer, S. P., Houston, Texas (1963)

Austin, S. B., Ch. Engr., G. & F., Augusta, Ga. (1963)

B

Babcock, D. L., Supv. B. & B., C. & N. W., Milwaukee, Wis. (1953)

Bach, S. A., B. & B. Supvr., M. P., Monroe, La. (1962)

Baker, F. A., Asst. Gen. Br. Insp., S. P., San Francisco, Calif. (1955)

Baker, R. C., Asst. Ch. Engr., C. & E. I., Chicago Heights, Ill. (1940)

Baldock, R. M., Weld. Engr., N. & W., Roanoke, Va. (1961)

Bangs, E. L., Gen. Br. Insp., C. & N. W., Chicago, Ill. (1957)

Barke, W. B., Asst. Supv. B. & B., G. N., Wenatchee, Wash. (1958)

Barnes, J. A., Engr. Trk., C. & N. W., Chicago, Ill. (1957)

Barsema, M., Asst. B. & B. Supv., C. & N. W., Chicago, Ill. (1958)

Baymiller, R. R., Div. Engr., S. P., Dunsmuir, Calif. (1961)

Beam, Y. C., Mast. Carp., S. A. L., Americus, Ga. (1945)

Beatty, A. G., Supv. Scl. & Wk. Equip., C. & N. W., Chicago, Ill. (1957)

Beaver, J. F., Ch. Engr., Sou., Washington, D. C. (1950)

Beeder, R. H., Ch. Engr.-Sys., A. T. & S. F., Chicago, Ill. (1958)

Bell, D. V., Mast. Carp., B. & O., Dayton, Ohio (1957)

Benson, O. C., Asst. Engr. M. of W., B. & M., Boston, Mass. (1952)

Beran, J. E., Draftsman, C. B. & Q., Chicago, Ill. (1964)

Beringer, M. A., Supt. Br. Erec., I. C., Chicago, Ill. (1929)

Berman, N., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1961)

Bertel, D. J., Asst. Dist. Engr., M. P., Osawatomie, Kans. (1957)

Bickham, D. O., Mast. Carp., C. B. & Q., McCook, Nebr. (1964)

Billmeyer, E. D., Br. & Struc. Engr., W. M., Baltimore, Md. (1955)

Bisbee, R. D., Div. Engr., P. & S. F., Slaton, Tex. (1947)

Bishop, I. A., Mast. Carp., S. A. L., Raleigh, N. C. (1955)

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Station E Louisville, Ky.

Black, A. R., Sp. Rep., S. P., Houston, Texas (1953)
Blackmore, J., Sr. Asst. B. & B. Supv., S. P., San Jose, Calif. (1960)
Blake, J. E., Jr., Supv. Struc., P. R. R., Williamsport, Pa. (1953)
Blake, V., Asst. Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1964)
Blanchard, L. C., Rdm., C. M. St. P. & P., Minneapolis, Minn. (1962)
Bleul, G. J., Engr. Bldgs., B. & O., Baltimore, Md. (1959)
Bober, H., B. & B. Engr., G. M. & O., Mobile, Ala. (1947)
Bodie, B. V., Vice Pres. & Gen. Mgr., G. M. & O., Mobile, Ala. (1951)
Boehling, H. A., Jr., Asst. Supvr. Brdg. Erec.-Sys., C. & O., Richmond, Va. (1948)
Boeser, G. F., Asst. Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1962)
Boling, E. C., Supv. B. & B., N. S., Raleigh, N. C. (1950)
Bolte, W. R., Motor Car Shop Fore., K. C. S., Pittsburg, Kans. (1959)
Booth, H. E., B. & B. Mast., C. N. R., Saskatoon, Sask., Canada (1957)
Born, J. O., Prin. Asst. Engr., M. C., Portland, Me. (1956)
Bost, M. R., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1959)
Bowman, H. A., Mast. Carp., F. W. & D., Wichita Falls, Tex. (1953)
Bowman, R. M., Asst. Supvr. Str., P. R. R., Altoona, Pa. (1954)
Bradfield, R. G., Engr., P. R. R., Chicago, Ill. (1957)
Brakensiek, W. E., Brdg. Design Engr., M. P., St. Louis, Mo. (1962)
Brandimarte, J. J., Jr., Supv. Struc., P. R R., Pittsburgh, Pa. (1947)
Brazeau, R., Gen. B. & B. Supvr., Q. N. S. & L., Sept Iles, Que., Canada (1961)
Bredfeldt, C., Ch. Drafts., C. M. St. P. & P., Chicago, Ill. (1955)
Bristow, L., Engr. Const., N. Y. C., Cleveland, Ohio (1964)
Brookshire, W. J., Supvr. Struct., D. & R. G. W., Glenwood Springs, Colo. (1962)
Brouse, R. G., Sr., Mast. Carp., C. B. & Q., Chicago, Ill. (1951)
Brown, E. J., Ch. Engr., C. B. & Q., Chicago, Ill. (1955)
Brown, W. S., Sp. Engr. Struct., B. & O., Baltimore, Md. (1959)
Bruns, H. W., Designer, I. C., Chicago, Ill. (1963)
Bryant, N. D., Asst. Brdg. Engr.-Const., St. L.-S. F., Springfield, Mo. (1961)
Budzileni, J., Struct. Designer, C. R. I. & P., Chicago, Ill. (1963)
Buckmaster, W. A., Asst. Div. Engr., B. & O. C. T., Chicago, Ill. (1951)
Bull, C. L., Supvr.-Rdwy. Maint., B. S., Fairfield, Ala. (1964)
Bunch, A. H., Gen. Fore. B. & B.-W. S., St. L.-S. F., Ft. Smith, Ark. (1951)
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Burkel, J. N., Drafts., M. P., St. Louis, Mo. (1951)
Burleson, H. S., Engr. B. & B., D. M. & I. R., Duluth, Minn. (1961)
Burns, D. H., Asst. Supvr. B. & B., G. N., Minot, N. D. (1964)
Burns, F. M., Asst. Engr.-B. & B., D. T. & I.-A. A., Dearborn, Mich. (1964)
Burpee, C. M., Editor, Wood Preserving News. American Wood Pres. Institute, Hinsdale, Ill. (1930)

C

Caldwell, F. O., Mast. Carp., S. A. L., Jacksonville, Fla. (1959)
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Camelle, E. J., B. & B. Supvr., S. P., Lafayette, La. (1954)
Cameron, W. M., Ch. Carp., C. M. St. P. & P., Milwaukee, Wis. (1955)
Campbell, H. G., Jr., Supvr. Struct., P. R. R., New York, N. Y. (1963)
Campbell, J. E., Gen. Supv. M. of W.&S. Weld., W. P., Oakland, Calif. (1954)
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Carlson, A. W., Engr. Br. & Struc., W. P., San Francisco, Calif. (1955)
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Casperson, D. F., Scale Insp., C. M. St. P. & P., Minneapolis, Minn. (1964)
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Chaffin, E. S., Supv. B. & B., N. & W., Crewe, Va. (1957)
Chamberlain, H. L., Supv. Struc., P. R. R., Indianapolis, Ind. (1956)
Chamberlain, P. C., Asst. to Engr. Struc., E.-L., Cleveland, Ohio (1941)
Chambers, J. W., Brdg. Const. Engr., M. P., St. Louis, Mo. (1962)
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Foreman, J. E., Jr., Engr. Struc.-Oper., B. & L. E., Greenville, Pa. (1957)
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Fox, J., Supv. M. of W., C. P., Montreal, Que., Can. (1955)
Fox, R. L., Proc. Engr.-Struc., Sou., Washington, D. C. (1935)
Franzen, E. T., Engr. Struct., M. P., St. Louis, Mo. (1957)
Free, J. D., Asst. Engr. Const., F. E. C., St. Augustine, Fla. (1961)
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Christian, J. E., Asst. Supv. B. & B.-W. Sup., (NF&G) C. & O., Rainelle, W. Va. (1959)
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Clark, K. L., Prin. Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1939)
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Coles, J. W., Asst. Supvr. B. & B., L. & N., Birmingham, Ala. (1964)
Collings, J. E., Ch. Carp., C. M. St. P. & P., Aberdeen, S. D. (1953)
Conner, L. E., Gen. Supv. Rdwy. Equip., S. A. L., Hamlet, N. C. (1959)
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Cook, J. C., Jr., Asst. Gen. Fore. B. & B.-W. S., G. C. & S. F., Ft. Worth, Tex. (1959)
Cooper, S. A., Ch. Engr., G. M. & O., Mobile, Ala. (1959)
Corbett, R. K., Gen. Fore. B. & B.-W. S., A. T. & S. F., San Bernardino, Calif. (1956)
Cothran, J. T., B. & B. Supvr., Sou., Columbia, S. C. (1963)
Cothran, R. F., B. & B. Supv., Sou., Knoxville, Tenn. (1957)
Crane, J. C., Asst. B. & B. Supv., S. P., Portland, Ore. (1957)
Creek, C. W., Asst. Supv. Struc., P. R. R., Chicago, Ill. (1957)
Crespo, M. J., Gen. Supv. Br. & Struc., W. P., San Francisco, Calif. (1956)
Crutchfield, W. T., Asst. Gen. Fore., A. T. & S. F., Fort Madison, Iowa (1964)
Cruikshank, A. W., B. & B. Supv., D. & H., Colonie, N. Y. (1950)
Currier, L. F., Asst. Br. Engr., L. & N., Louisville, Ky. (1958)
Cushman, D. G., Asst. B. & B. Supvr., C. & E. I., Salem, Ill. (1963)

D

Dahlberg, A. R., B. & B. Supv., W. M., Hagerstown, Md. (1957)
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Davidson, J. W., Engr. Br., C. B. & Q., Chicago, Ill. (1957)
Davis, H. E., Supv. B. & B., N. Y. C., Mattoon, Ill. (1940)
Davis, L. M., Asst. Gen. Fore. B. & B.-W. S., A. T. & S. F., Newton, Kans. (1963)
Day, F. D., Area Engr. Struc., P. R. R., Pittsburgh, Pa. (1949)
Deal, C. D., Supv. Wk. Equip. & Weld., N. Y. C., Verplanck, N. Y. (1959)
Deno, L. J., Staff Engr.-Maint., C. & N. W., Chicago, Ill. (1947)
Derryberry, J. T., Supv. B. & B., W. M., Cumberland, Md. (1955)
DeValle, J. W., Ch. Engr.-Brdgs. & Struct., Southern, Atlanta, Ga. (1959)
DeWitt, E. C., Asst. B. & B. Supvr., S. P., San Francisco, Calif. (1961)
Dick, M. H., Vice Pres. & Ed., Ry. Trk. & Struc., Chicago, Ill. (1937)
Dickinson, C. S., Supvr. B. & B., C. & O., South Shore, Ky. (1953)
Diehl, C. M., Sr. Asst. Engr., W. M., Cumberland, Md. (1959)
Dimick, C. A., Supv. B. & B., N. Y. C., Springfield, Mass. (1957)
Dixon, C. E., Supv. B. & B., M. C., Bangor, Me. (1955)
Doggett, T. S., Supvr. B. & B. & M. Force, R. F. & P., Richmond, Va. (1959)
Dove, R. E., Assoc. Ed., Ry. Trk. & Struc., Chicago, Ill. (1934)
Dower, E. M., Asst. Engr., D. & H., Albany, N. Y. (1964)
Duffy, P. E., Supvr. B. & B., G. N., Minneapolis, Minn. (1957)
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Eargle, J. M., Mast. Carp., S. A. L., Atlanta, Ga. (1953)
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Eisemann, J. E., Ch. Engr.-W. L., A. T. & S. F., Amarillo, Tex. (1961)
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Ellis, J. S., Supvr. B. & B.-W. S., C. & O., Grand Rapids, Mich. (1957)
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Engle, T. J., Engr. Bldg., C. R. I. & P., Chicago, Ill. (1959)
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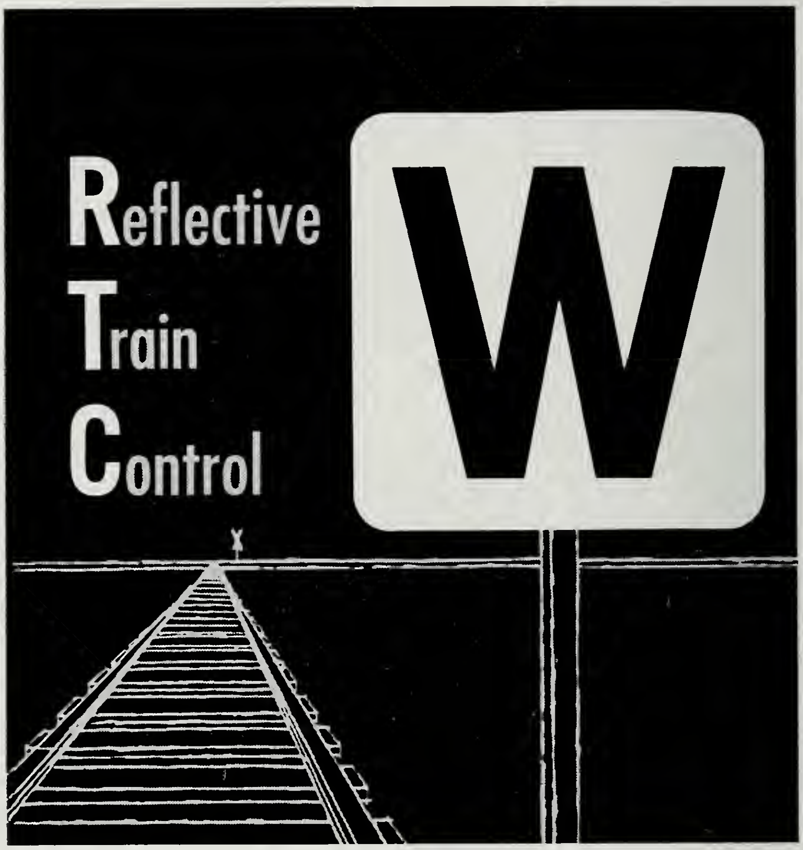

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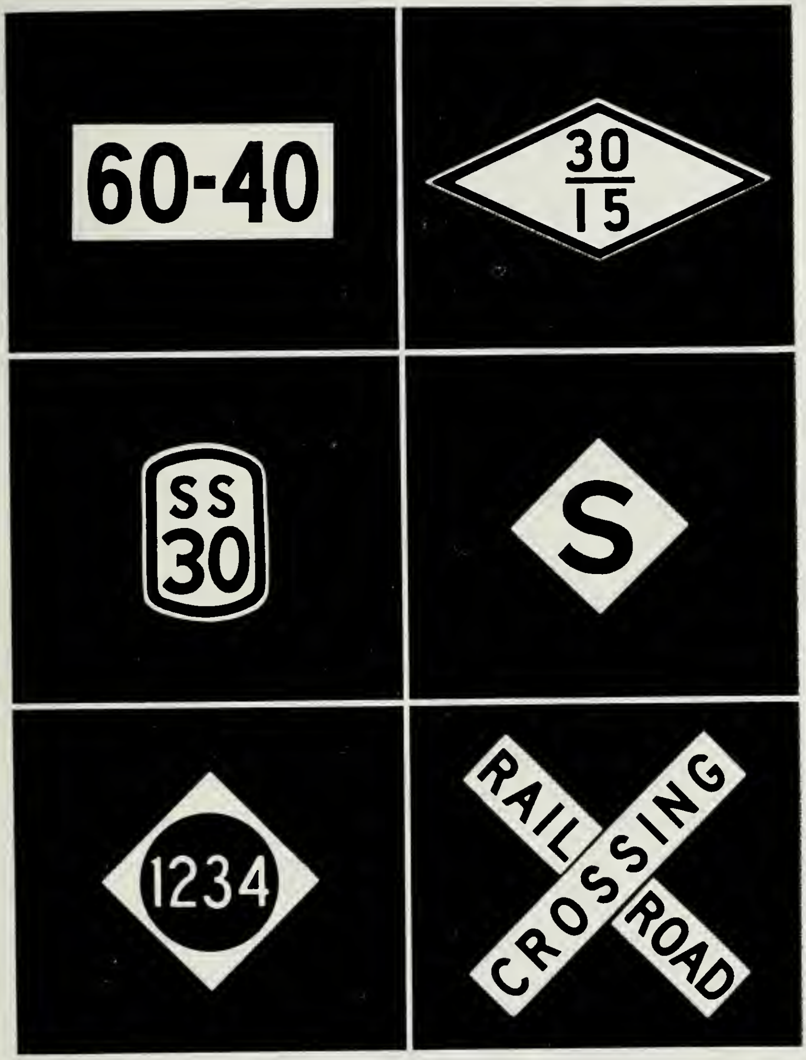

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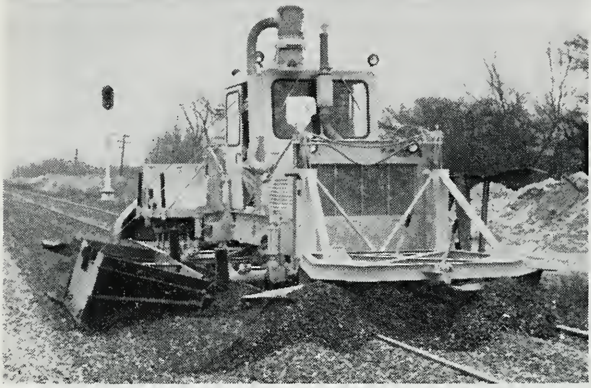

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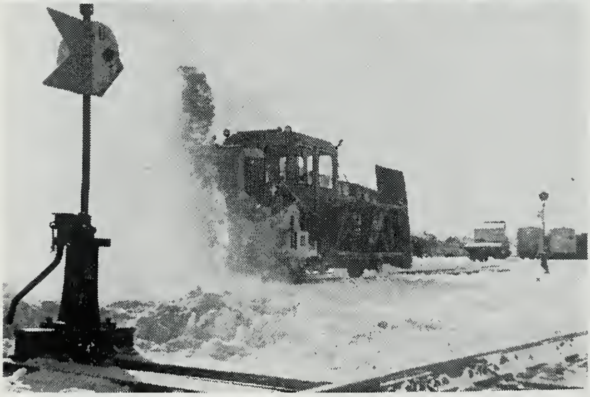

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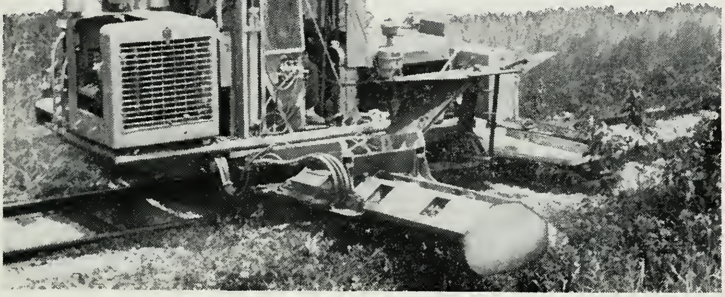

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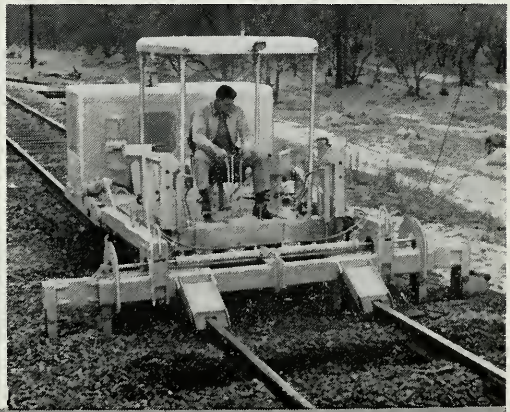

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Hopton, J. P., Engr. Maint., C. U. T., Cincinnati, Ohio (1955)
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Howard, P. D., R. R. Supv., Minn. Mining & Mfg., St. Paul, Minn. (1957)
Howard, W. A., B. & B. Supvr., S. P., Ennis, Texas (1963)
Howe, W. C., Engr. B. & B., B. & L. E., Greenville, Pa. (1959)
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Huckaby, V. T., Asst. Div. Engr., M.-K.-T., Parsons, Kans. (1947)
Huffman, W. H., Asst. Ch. Engr.-Const., C. & N. W., Chicago, Ill. (1941)
Humphreys, R. W., Asst. to Vice Pres.-Oper., N. P., St. Paul, Minn. (1947)
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Hunter, A. L., Struc. Insp., B. & L. E., Greenville, Pa. (1960)
Huntsman, W. J., Supvr. Struc., D. & R. G. W., Murray, Utah (1957)
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Hutchens, J. W., Gen. Supvr. Wk. Equip., S. P., West Oakland, Calif. (1961)
Hutcheson, F. W., Supv. B. & B., C. & O., Newport News, Va. (1938)
Hutcheson, T. B., Ch. Engr., S. A. L., Richmond, Va. (1961)
Hutchinson, D. G., Asst. B. & B. Supvr., W. P., Elko, Nev. (1950)
Hutto, J. E., Gen. Brdg. Insp., S. A. L., Savannah, Ga. (1951)
Hynes, E. J., Transp. Engr., D. T. & I., Dearborn, Mich. (1958)

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Jackson, C. S., Jr. Engr., G. M. & O., Bloomington, Ill. (1962)
Jacobs, T. F., Brdg. & Str. Engr., G. T. W., Detroit, Mich. (1962)
Jarratt, M., Wtr. & Fuel Supv., S. P., Tucson, Ariz. (1950)
Jawor, J. J., Br. Insp., P. R. R., Chicago, Ill. (1959)
Jenkins, H. W., Ch. Engr., N. Y. N. H. & H., New Haven, Conn. (1940)
Jentoft, L. H., (Ret.) Asst. Ch. Engr. M. of W., E.-L., Lakewood, Ohio (1959)
Johnson, A. C., Engr. B. & B., E. J. & E., Joliet, Ill. (1944)
Johnson, A. E., B. & B. Supvr., Sou., Chattanooga, Tenn. (1963)
Johnson, A. J., Asst. Mast. Carp., B. & O., Garrett, Ind. (1964)
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Johnston, G. H., Bldg. Supt., A. T. & S. F., Topeka, Kans. (1950)
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Jones, W. J., Engr. Maint. of Way & Struct., S. P., San Francisco, Calif. (1962)
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Little, H. C., Supv. W. S., I. C., New Orleans, La. (1948)
Littlefield, R. I., Asst. B. & B. Supv., S. P., Oakland, Calif. (1960)
Lodeski, J. B., Ch. Draftsman, C. & N. W., Chicago, Ill. (1964)
Logan, P. W., B. & B. Insp., N. Y. C. & St. L., Lima, Ohio (1964)
Loggins, L. A., Ch. Engr., T. & L. Lines, S. P. Houston, Tex. (1959)
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Long, W. R., Asst. B. & B. Supvr., S. P., Albany, Ore. (1963)
Lowry, J. M., Ch. Engr., St. L. S. W., Tyler, Tex. (1950)
Loznak, S. R., B. & B. Supvr., A. A., Owosso, Mich. (1964)
Lucas, H. F., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1952)
Luce, W. L., Mast. Carp., E.-L., Youngstown, Ohio (1952)
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Lundgren, H. M., B. & B. Mast., C. N. R., Winnipeg, Man., Canada (1957)
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McDermott, B. F., Div. Engr., C. & N. W., Norfolk, Nebr. (1960)
McDiarmid, R. J., Supv. B. & B., E. J. & E., Joliet, Ill. (1957)
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McGrew, B. H., Supv. B. & B., St. L. S. W., Tyler, Tex. (1951)
McGrew, F. O., Ch. Carp., C. M. St. P. & P., Minneapolis, Minn. (1948)
McGuffee, R. C., Jr., Engr., T. Ry., A. S. D., Mobile, Ala. (1961)
McHaffie, J. N., Asst. Supvr. B. & B., G. N., Minneapolis, Minn. (1962)
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McKenney, C. E., Sys. Scl. Insp., N. Y. C. & St. L., Ft. Wayne, Ind. (1956)
McKibben, D. H., Supv. Struc., P. R. R., Harrisburg, Pa. (1951)
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Manson, A., Div. Engr., L. & N., Birmingham, Ala. (1957)
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Marriott, L. S., Asst. to Engr. Bldgs., I. C., Chicago, Ill. (1960)
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Martin, R. T., Supvr. B. & B., F. E. C., Miami, Fla. (1960)
Martyn, G. W., Off. Engr., E. J. & E., Joliet, Ill. (1959)
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Mays, J. W. N., Asst. Engr.-Sys., P. R. R., Philadelphia, Pa. (1947)
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Meserve, E. S., Supvr. B. & B., B. & M., Dover, N. H. (1949)
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Mince, F. S., B. & B. Supvr., Sou., Big Stone Gap, Va. (1963)
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Moris, R. F., B. & B. Supv., N. Y. C. & St. L., Ft. Wayne, Ind. (1955)
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Myrind, T. A., Asst. B. & B. Supvr., S. P., Fremont, Calif. (1964)

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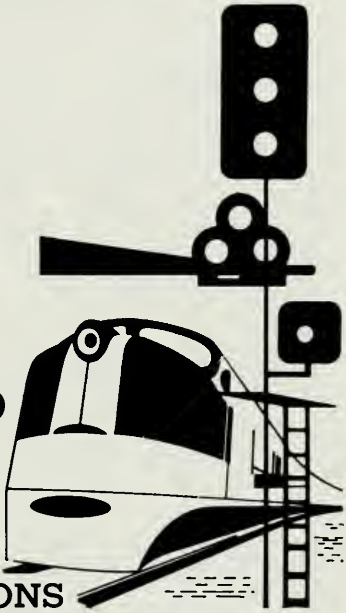

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Phelps, C. E., B. & B. Supv., A. & W. P. - W. of A., & Ga. R. R., Warrenton, Ga. (1949)

Phillips, L. K., B. & B. Insp., W. M., Cumberland, Md. (1957)

Planchon, I., Gen. Fore. B. & B.-W. S., St. L.-S. F., Tulsa, Okla. (1961)

Plourde, L. (Ret.), Sr. Mast., C. N. R., St. Paul L Ermite, Que., Canada (1963)

Pollock, J. K., Asst. B. & B. Supvr., S. P., Norden, Calif. (1961)

Pool, R. M., Asst. B. & B. Supvr., S. P., Lafayette, La. (1964)

Pound, E. R., Mast. Carp., B. & O., Newark, Ohio (1952)

Prentiss, E. W., Engr. B. & B., P. R. R., Philadelphia, Pa. (1959)

Presthus, E. J., Supvr. B. & B., N. P., Missoula, Mont. (1964)

Pritchard, B. L., Div. Engr., A. T. & S. F., Amarillo, Texas (1956)

Pritchett, J. S., Supt. Struct. & Materials, C. of G., Macon, Ga. (1961)

Prober, H. W., Sr. Asst. B. & B. Supv., S. P., Los Angeles, Calif. (1957)

Prude, G. F., Asst. Supvr. B. & B., S. P., Houston, Tex. (1951)

R

Raessler, V. D., Supvr. B. & B. & W. F., I. C., Memphis, Tenn. (1951)

Rainey, W. H., B. & B. Supvr., S. P., San Antonio, Tex. (1956)

Rankin, R. C., Design. Engr., St. L. S. W., Tyler, Tex. (1962)

Rankin, W. H., Sr. Struct. Engr., St. L.-S. F., St. Louis, Mo. (1961)

Rapier, L. F., Supv. B. & B., G. M. & O., Bloomington, Ill. (1946)

Raver, H. E., Engr. Struc.-Design, L. I., Jamaica, N. Y. (1952)

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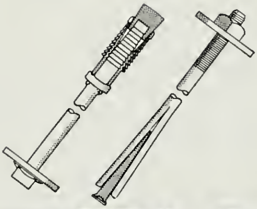

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Reed, T. C., Br. Insp., L. & N., Louisville, Ky. (1954)

Reese, C. L., Br. Insp., G. M. & O., Philadelphia, Miss. (1958)

Reese, C. M., Gen. Fore. B. & B., G. C. & S. F., Temple, Tex. (1953)

Reeves, J. I., Asst. to B. & B. Supvr., G. M. & O., Bloomington, Ill. (1964)

Reynolds, M. L., B. & B. Supvr., S. P., Bakersfield, Calif. (1958)

Reynolds, T. A., Asst. Supvr. Str., P. R. R., Buffalo, N. Y. (1961)

Rice, E. D., B. & B. Supv., C. & E. I., Danville, Ill. (1949)

Richardson, F., Jr., Gen. Fore. B. & B.-W. S., St. L.-S. F., Springfield, Mo. (1962)

Ridgeway, J. J., Engr. Struc.-Proc., B. & L. E., Greenville, Pa. (1957)

Riggs, W. K., B. & B. Supv., C. & N. W., West Chicago, Ill. (1959)

Riley, C. R., Asst. to Ch. Oper. Off., B. & O., Baltimore, Md. (1959)

Robey, W. E., Br. Engr. Sys., A. T. & S. F., Chicago, Ill. (1960)

Robinson, N. R., B. & B. Fore., S. P., Sacramento, Calif. (1934)

Rode, L. A., Gen. Br. Insp., E.-L., Newark, N. J. (1948)

Rodgers L. T., Mast. Carp., B. & O., Chillicothe, Ohio (1963)

Rogers, L. W., Designer, I. C., Chicago, Ill. (1960)

Rothell, R. D., Gen. B. & B. Supv., Sou., Charlotte, N. C. (1957)

Rothwell, G. F., Engr. Plan., Wabash, St. Louis, Mo. (1961)

Rowland, J. W., Asst. Engr. Const., L. I., Jamaica, N. Y. (1956)

Rudisill, D. E., Asst. Ch. Engr. Maint., P. R. R., Philadelphia, Pa. (1959)

Runde, E. E., Ch. Masonry Insp., I. C., Chicago, Ill. (1959)

Russell, C. E., Supvr. Water Serv., I. C., Chicago, Ill. (1953)

Rust, R. B., Jr., Asst. Div. Engr., Southern, Chattanooga, Tenn. (1957)

Ryan, G. M., Asst. to Gen. B. & B. Fore., N. Y. N. H. & H., New Haven, Conn. (1963)

Rymer, J. R., Div. Engr., B. & O., Cumberland, Md. (1957)

S

Saether, A. H., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1959)

Safley, J. R., B. & B. Supv., S. P., San Francisco, Calif. (1945)

St. Pierre, M. P., Asst. B. & B. Mast., C. N., Edmundston, N. B., Can. (1959)

Salmon, J. M., Jr., Ch. Engr., Clinchfield, Erwin, Tenn. (1938)

Sandberg, C. H., Ch. Engr.-East. Lines, A. T. & S. F., Topeka, Kans. (1958)

Sanders, C. R., Struct. Designer, S. P., Houston, Texas (1963)

Sanders, G. A., Asst. B. & B. Supvr., S. P., Sacramento, Calif. (1960)

Sanderson, J. G., Asst. W. S. Fore., St. L.-S. F., Amory, Miss. (1959)

Sarris, P. T., Asst. Engr., Southern, Atlanta, Ga. (1955)

Sartore, D. V., Asst. Engr. Brdgs., C. B. & Q., Chicago, Ill. (1961)

Sathre, C. O., B. & B. Supv., C. & N. W., Madison, Wis. (1950)

Saunders, T. D., Dir. of Plan. & Res., Ont. Nor., North Bay, Ont., Can. (1930)

Savage, F. E., Asst. B. & B. Supv., N. P., Minneapolis, Minn. (1957)

Schlaf, E. R., Supt. Fire Prev., I. C., Chicago, Ill. (1947)

Schmitz, J. F., B. & B. Supt., M. P., Little Rock, Ark. (1960)

Schweitzer, E., Res. Engr., U. P., The Dalles, Oreg. (1959)

Scites, P. E., Asst. Supv. B. & B., C. & O., Hinton, W. Va. (1950)

Seitz, H., Engr. of Struct., B. & O., Baltimore, Md. (1959)

Seley, L. L., Mast. Carp., C. B. & Q., Hannibal, Mo. (1953)

Seller, J. B., Asst. Brdg. Engr., L. & N., Louisville, Ky. (1957)

Seltzer, J. W., Asst. Engr., P. R. R., Cincinnati, Ohio (1958)

Shafer, W. R., Struct. Designer, S. P., Houston, Texas (1963)

Shamblin, R. E., Supv. B. & B., N. & W., Bluefield, W. Va. (1957)

Sharkey, J. J. (Ret.), Gen. Fore. B. & B., P. R. R., Short Hills, N. J. (1951)

Short, W. L., Brdg. Maint. Engr., M. P., St. Louis, Mo. (1951)

Sielert, E. R., Gen. Fore., A. T. & S. F., Emporia, Kans. (1961)

Simmons, E. R., Asst. Engr. Brdgs., S. P., San Francisco, Calif. (1955)

Simmons, R. G., Gen. Rdm., C. M. St. P. & P., Chicago, Ill. (1957)

Simonson, E. F., B. & B. Supv., S. I., Sandpoint, Ida. (1958)

Simpson, L. W., Mast. Carp., B. & O., Pittsburgh, Pa. (1959)

Sims, H. L., B. & B. Asst. Supvr., C. & W. I., Chicago, Ill. (1964)

Sinclair, C. H., Asst. Supv. B. & B., C. & N. W., Milwaukee, Wis. (1954)

Slagle, G. P., Ch. Carp., C. M. St. P. & P., Milwaukee, Wis. (1948)

Smith, A. C., Asst. Engr. Brdgs., Sou., Charlotte, N. C. (1963)

Smith, A. E., Asst. Gen. Mgr.-Ch. Engr., C. G. W., Oelwein, Iowa (1958)

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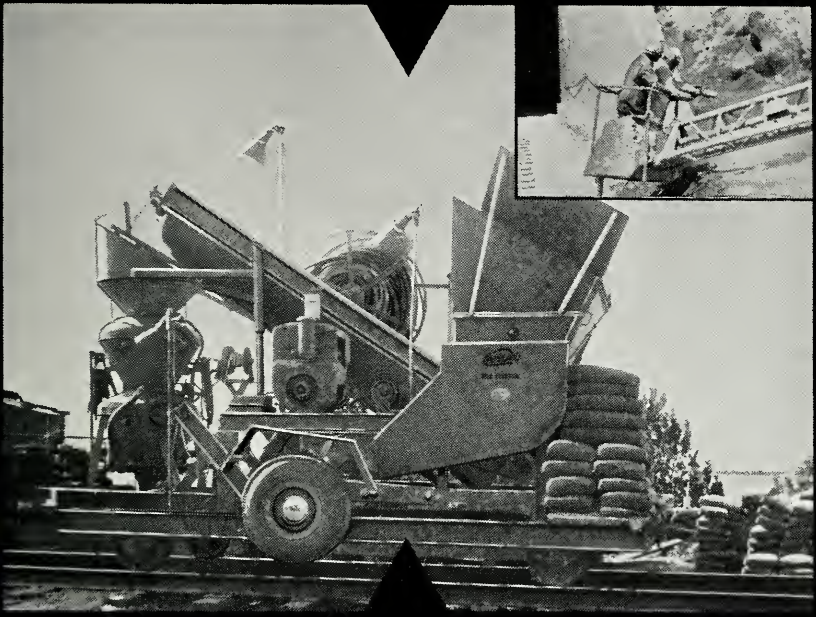

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Smith, L. D., Jr., Asst. Engr.-Bldgs., C. & O., Huntington, W. Va. (1963)
Smith, R. E., Asst. B. & B. Mast., C. N. R., Hornepayne, Ont., Canada (1963)
Smith, R. H., Jr., Div. Engr., P. R. R., Philadelphia, Pa. (1957)
Snyder, E. F., Asst. to Ch. Engr., I. C., Chicago, Ill. (1948)
Snyder, R. E., Asst. Engr., C. & N. W., Green Bay, Wis. (1961)
Solarte, H., Asst. to Engr. Brdgs., C. R. I. & P., Chicago, Ill. (1963)
South, J. E., Sys. Engr. Struc., P. R. R., Philadelphia, Pa. (1959)
Spofford, F. R., Asst. to Vice Pres.-Oper., B. & M., Boston, Mass. (1940)
Stade, A. F., Asst. B. & B. Supvr., S. P., San Antonio, Tex. (1962)
Stadter, C. O., B. & B. Supt., M. P., Osawatomie, Kans. (1955)
Stanczyk, W., Designer, C. M. St. P. & P., Chicago, Ill. (1957)
Starling, S. L., Asst. Mast. Carp., S. A. L., Savannah, Ga. (1961)
Steel, J. V., Engr. Acct., U. T. Co., Dallas, Tex. (1953)
Stephens, B. M., Asst. Gen. Mgr.-T. & L. Lines, S. P., Houston, Texas (1946)
Stephens, T. J., Engr. Insp., U. P., Kansas City, Mo. (1958)
Stinebaugh, J. H., Supv. W. S. & Rdwy. Mach., I. C., Carbondale, Ill. (1951)
Stouffer, R., Mech. Insp., I. C., Crown Point, Ind. (1961)
Street, M. R., Asst. B. & B. Supvr., G. N., Minot, N. D. (1962)
Struther, B. A., Asst. Div. Engr., S. P., Tucson, Ariz. (1961)
Sturm, W. C., Designer, E. J. & E., Joliet, Ill. (1962)
Sturman, J. J., Engr.-Matls.-Struct., B. & O., Baltimore, Md. (1959)
Stutes, S. A., Asst. Div. Engr., S. P., Lafayette, La. (1959)
Sullivan, P., Engr. Drad. & Soil Cont., W. P., Oroville, Calif. (1957)
Swanson, A. M., B. & B. Supvr., B. A. & P., Anaconda, Mont. (1961)
Swanson, R. S., B. & B. Supvr., N. P., Duluth, Minn. (1960)
Swanson, W. C., Brdg. Insp., N. Y. C., Knox, Ind. (1963)
Switzer, G., Gen. Supv. Struc. & Wk. Equip., W. P., Oakland, Calif. (1949)

T

Talman, H. S., Gen. Supvr. B. & B., C. & O., Huntington, W. Va. (1963)
Tanner, C. L., Gen. Fore. B. & B.-W. S., P. & S. F., Slaton, Tex. (1958)
Tantillo, A. J., Arch. Engr., C. & W. I., Chicago, Ill. (1962)
Tardy, F. E., Asst. Div. Engr., S. P., Tucson, Ariz. (1953)
Taylor, W. L., B. & B. Supv., Sou., Jasper, Ala. (1950)
Termunde, W. L., Asst. Rdm., B. Ry. of C., Chicago, Ill. (1956)
Tetreault, L. J., B. & B. Fore., N. Y. N. H. & H., Providence, R. I. (1936)
Thatcher, C. H., Jr., Asst. Engr., C. & N. W., Boone, Iowa (1958)
Thomas, A. A., Asst. to Ch. Engr., C. & N. W., Chicago, Ill. (1961)
Throckmorton, W. B., Ch. Engr., C. R. I. & P., Chicago, Ill. (1957)
Thun, W. A., Jr., Supvr. Trk., P. R. R., Cincinnati, Ohio (1961)
Tieman, L. G., Div. Engr., C. & N. W., Green Bay, Wis. (1956)
Tilley, E. L., Br. Insp., I. C., Memphis, Tenn. (1956)
Toal, T. W., Div. Engr., C. R. I. & P., Blue Island, Ill. (1961)
Towle, C. L., Vice Pres.-Oper., D. T. & I., Dearborn, Mich. (1959)
Tracy, D. E., B. & B. Supvr., S. P., Oakland, Calif. (1956)
Tracy, S. E., Supt. Wk. Equip., C. B. & Q., Chicago, Ill. (1960)
Trenning, D. P., Draftsman, C. M. St. P. & P., Chicago, Ill. (1962)
Trewin, H., Rdm., C. N. R., Moncton, N. B., Canada (1963)
Trickey, R. E., Supt. B. & B., B. & A., Houlton, Me. (1957)
Trulove, J. D., B. & B. Supv., S. P., Ogden, Utah (1945)
Turner, G. M., Asst. B. & B. Supv., N. P., Pasco, Wash. (1960)
Tustin, E. O., Asst. Supvr. B. & B., I. C., Chicago, Ill. (1963)
Tustin, W. S., Asst. Engr., I. C., Chicago, Ill. (1963)
Tyckoson, E. G., Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1954)
Tyler, W. R., Jr., Div. Engr., U. P., Pocatello, Ida. (1959)

U

Urquides, E. L., Asst. Supvr. B. & B., S. P., West Oakland, Calif. (1960)

V

Vanderpool, G. R., Br. Engr.-West. Lines, A. T. & S. F., Amarillo, Tex. (1959)
Vandiver, V. J., Asst. B. & B. Supv., S. P., Dunsmuir, Calif. (1958)
Van Scoyoc, L., Designer, I. C., Chicago, Ill. (1960)
Veldheer, H., Asst. Supv. B. & B., C. & O., Grand Rapids, Mich. (1959)
Von Behren, G., Asst. Supv. Struc., P. R. R., Baltimore, Md. (1956)

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Wachter, C. E., B. & B. Mast., C. N. R., Port Arthur, Ont., Canada (1957)
Waisanen, R. M., Asst. Arch. Engr., C. & N. W., Chicago, Ill. (1963)
Walker, G. P., Supt. B. & B., M. P., Houston, Texas (1929)
Wall, R., Supv. B. & B., Sou., Selma, Ala. (1948)
Walton, K. D., Asst. B. & B. Supv., N. P., Minneapolis, Minn. (1960)
Ward, R. A., B. & B. Mast., C. N. R., Campbellton, N. B., Canada (1961)
Ware, W., Div. Engr., C. R. I. & P., Little Rock, Ark. (1956)
Warfield, H. Jr., (Ret.), Insp. M. of W., P. R. R., New Brunswick, N. J. (1952)
Warfield, W. B., Supvr. Struct., P. R. R., Townson, Md. (1951)
Watanabe, L. H., Designer, I. C., Chicago, Ill. (1963)
Waterman, L. B., Asst. Supt., B. & O., Baltimore, Md. (1959)
Watkins, A. B., B. & B. Supvr., Southern, Winston Salem, N. C. (1960)
Watkins, J. F., B. & B. Supv., Sou., Tuscumbia, Ala. (1958)
Weaver, W. R., Ch. Mech. Off. & Ch. Engr., P. & S., Brookville, Pa. (1951)
Webber, G. R., B. & B. Fore., C. M. St. P. & P., Tacoma, Wash. (1948)
Weikal, J. K., Div. Engr., E.-L., Youngstown, Ohio (1959)
Weller, M. E., Sr. Designer, E. J. & E., Joliet, Ill. (1962)
Weller, R. C., Asst. Engr. Maint., C. N. R., London, Ont., Canada (1957)
Wenzel, J. R., B. & B. Supvr., C. & N. W., Norfolk, Nebr. (1963)
Westerman, C. J., Asst. B. & B. Supvr., S. P., Bakersfield, Calif. (1962)
White, E. K., Asst. Gen. Brdg. Insp., C. & N. W., Stone Park, Ill. (1961)
White, L. H., Supv. B. & B., I. C., New Orleans, La. (1946)
White, S., Gen. B. & B. Supv., S. P., San Francisco, Calif. (1946)
Whitfield, P. V., Supvr. Auto & Wk. Equip., S. P., Reno, Nev. (1964)
Wiemer, H. C., B. & B. Supvr., N. P., Tacoma, Wash. (1957)
Wiklund, W. W., Supvr. B. & B., G. N., Spokane, Wash. (1955)
Williams, D. R., Br. Insp., C. & E. I., Danville, Ill. (1956)
Williams, J. M., Masonry Insp., I.C., Chicago, Ill. (1963)
Williams, J. R., Engr. Brdgs., C. R. I. & P., Chicago, Ill. (1959)
Williams, N. H., Trk. Supv.-Sys., D. & H., Albany, N. Y. (1947)
Williams, T. S., Engr. Bldgs., S. A. L., Richmond, Va. (1961)
Williamson, H. M., Ch. Engr.-Sys., S. P., San Francisco, Calif. (1960)
Wilson, H. E., Asst. Ch. Engr.-Sys., A. T. & S. F., Chicago, Ill. (1959)
Wilson, H. M., Supv. Struc., P. R. R., Chicago, Ill. (1953)
Wilson, R. P., Supv. B. & B., C. & O., Hinton, W. Va. (1948)
Wintoniak, S. G., Area Engr.-Struct., P. R. R., Philadelphia, Pa. (1953)
Wohlschlaeger, M. W., Engr. Grade Separat., M. P., St. Louis, Mo. (1958)
Wold, O. R., B. & B. Supv., N. P., Spokane, Wash. (1957)
Wood, R. E., Supv. B. & B., G. N., Great Falls, Mont. (1954)
Woolford, F. R., Ch. Eng., W. P., San Francisco, Calif. (1950)
Worden, R. K., Gen. Fore. B. & B.-W. S., G. C. & S. F., Ft. Worth, Tex. (1954)

Y

Yaw, D. M., Mast. Carp., E.-L., Buffalo, N. Y. (1951)
Youngblood, R. A., Proc. Supt. B. & B., C. of G., Savannah, Ga. (1957)

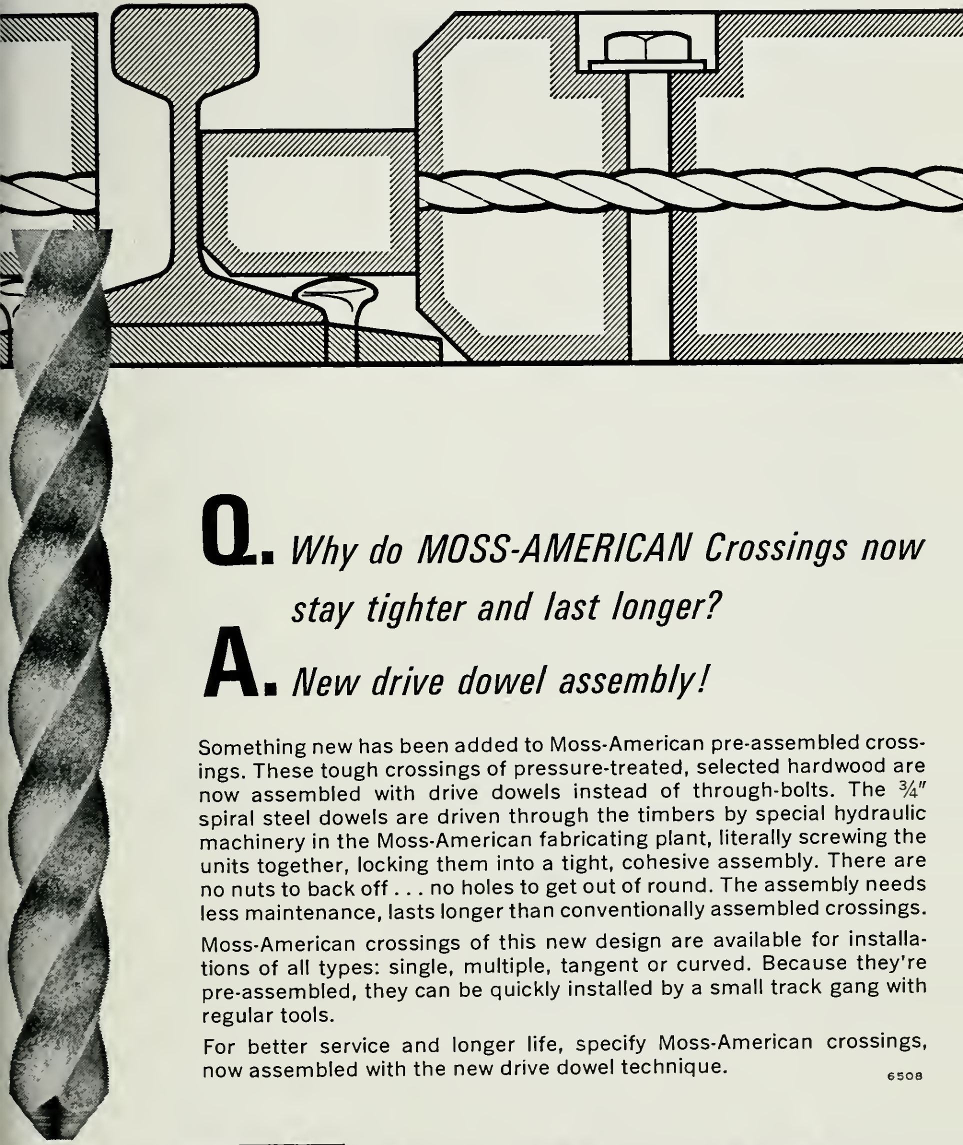
Z

Zapfe, E. J., (Ret.), Asst. Ch. Engr. & Supt. B. & B., G. B. & W., Green Bay, Wis. (1952)
Zigler, L. A., Gen. Fore. B. & B.-W. S., A. T. & S. F., La Junta, Colo. (1961)

LIFE MEMBERS

A

	Joined In
Anderson, A., (Ret.), Engr. Grade Cross., N. Y. C., Rosemont Route, Box 56, Colorado Springs, Colo.	1947
Anderson, J. L., (Ret.), Supvr. B. & B., M. P., 801 Pacific St., Osawatomie, Kans.	1931
Anderson, R. D., (Ret.), Div. Engr., C. & N. W., Marvin Hughitt Hotel, Huron, S. D.	1923



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Barr, H. L., (Ret.), Div. Engr., C. & N. W., 945 E. 6th St., Chadron, Nebr.	1938
Benson, G. W., (Ret.), Div. Engr., C. of G., 657 Woodridge Dr., Macon, Ga.	1940
Block, M., (Ret.), Asst. to Ch. Engr., I. C., 7115 S. Oglesby Ave., Chicago, Ill.	1948
Borchert, W. C. (Ret.), Div. Engr., L. & A., 917 Stephenson St., Shreveport 38, La.	1942
Bost, M. A., (Ret.) Asst. Engr., C. M. St. P. & P., 322 S. Carolina, Mason City, Iowa	1935
Brice, W. T., (Ret.), B. & B. Mast., C. N., General Delivery, Riverhurst, Sask., Can.	1946
Budzenski, F. N., (Ret.), Gen. Fore., C. & N. W., 800 Pine St., Antigo, Wis.	1938
Bunge, W. H. (Ret.), Asst. Engr., M. P., 4510 Waring, Houston 27, Texas	1941
Burch, E. E., (Ret.), Brdg. Engr., C. M. St. P. & P., 3926 W. 147th Place, Midlothian, Ill.	1945

C

Carter, J. W. (Ret.), B. & B. Supv., Virginian, 2410 Brandon Ave., S. W., Roanoke, Va.	1947
Chaney, A. B., (Ret.), Engr. M. of W., M. P., 3 Sun Valley Rd, Little Rock, Ark.	1947
Christianson, H. B., (Ret.), Sp. Engr., C. M. St. P. & P., 997 Bob O'Link Rd., Highland Park, Ill.	1928
Church, H. M., (Ret.), Gen. Supv. B. & B., C. & O., 509 No. Blvd., Richmond, Va.	1939
Cole, G., (Ret.), B. & B. Gen. Fore., A. T. & S. F., Burlingame, Kans.	1949
Collier, P. B., (Ret.), Supt. Scales, M. P., 287 Washington St., Camden, Tenn.	1938
Colvin, A. A., (Ret.), Div. Engr., C. & N. W., 1000 Prospect Ave., Norfolk, Nebr.	1937
Converse, D. W., (Ret.), Br. Engr., A. C. & Y., 360 Litchfield Road, Akron, Ohio	1940
Cota, G. M., (Ret.), Ch. Clk., Engr. Dept., C. of V., Box 114, St. Albans, Vt.	1913
Cramer, F. H., (Ret.), Br. Engr., C. B. & Q., 2739 Agatite Ave., Chicago, Ill.	1927
Curie, H. D., (Ret.), Mast. Carp., B. & O., Garrett, Ind.	1942

D

Decker, H. H., (Ret.), Engr. of M., C. & N. W., 2915 Ingersoll Ave., Des Moines, Ia.	1908
Dick, H. M., (Ret.), Supv. Struc., P. R. R., 302 Walnut Circle, Shiremanstown, Pa.	1942
Duchac, J. V. (Ret.), Supv. B. & B., C. & N. W., 525 Virginia St., Antigo, Wis.	1927
Duffie, F. J., (Ret.), Engr. Serv. Rep., Oxweld R. R. Dept., Linde Co., 610 W. 6th St., Sterling, Ill.	1946

E

Eischenlaub, C. M. (Ret.), Supt., S. D. & A. E., San Diego, Calif.	1943
Engman, V. E., (Ret.), Ch. Carp., C. M. St. P. & P., 2936 44th Ave., So., Minneapolis, Minn.	1920

F

Firehammer, L. M., (Ret.), Supvr. B. & B., I. T., 213 E. Elm St., Gillespie, Ill.	1919
Flanagan, F. L., (Ret.), Ry. Sls., Valspar Corp., Detroit Graphite Div., 7701 W. 47th St., Lyons, Ill.	1937
Forseth, C. E., (Ret.), Div. Engr., W. P., 726 Camino Amigo, Danville, Calif.	1950
Fronabarger, H. C., (Ret.), B. & B. Supvr., T. & P., 554 S. Summitt Ave., Apt. 1119, Ft. Worth, Tex.	1949

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Geyer, C. J., (Ret.), Vice Pres., C. & O., 1412 Wilmington Ave., Richmond, Va.	1928

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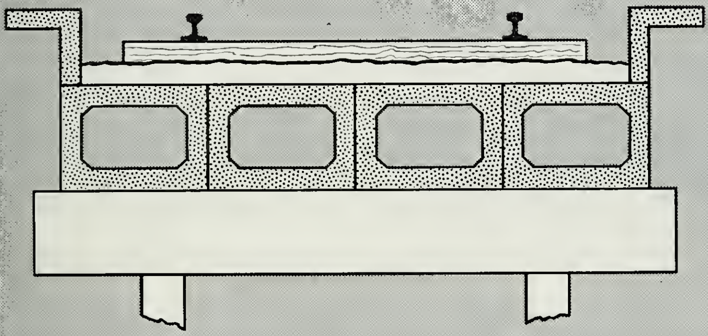

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Glander, A. M., (Ret.), Ch. Carp., C. M. St. P. & P., 806 Oakland Place, Austin, Minn. 1936
Gunderson, E., (Ret.), Supt. B. & B., C. St. P. M. & O., Altoona, Wis. 1927

H

Hampton, A. A., (Ret.), Supvr. B. & B., M. P., 903 S. Second St., Monroe, La. 1947
Hancock, J. S., (Ret.), Brdg. Engr., D. T. & I., 4921 Calhoun Ave., Dearborn, Mich. 1916
Harman, W. C., (Ret.), Supv. B. & B., S. P., 656 Cedar St., San Carlos, Calif. 1911
Harris, A. R., (Ret.), Engr. Brdgs., C. & N. W., 1440 Regina Dr., West, Largo, Fla. 1940
Heiszenbuttel, H., (Ret.), B. & B. Supv., C. & N. W., 808 So. 3rd St., Norfolk, Neb. 1917
Hemstad, B., (Ret.), Mast. Carp., G. N., 1120 Becker Ave., West, Willmar, Minn. 1937
Hillman, A. B., (Ret.), Ch. Engr., B. Ry. of C., 14030 Tracy Ave., Apt. 2-A, Riverdale, Ill. 1942
Hillman, F. W., (Ret.), Asst. Engr. M. W., C. & N. W., 1104 N. Harlem Ave., River Forest, Ill. 1917
Hoyt, A. C., (Ret.), Engr. B. & B., E. J. & E., Albuquerque, N. M. 1947
Hubbard, M. J., (Ret.), Asst. Ch. Engr.-Sys., C. & O., 243 S. Boulevard, Huntington, W. Va. 1948
Huckstep, W. A., (Ret.), Gen. Bldg. Supvr., M. P., Park LaJolla Apts., 5331 LaJolla Blvd., LaJolla, Calif. 1941
Huntsman, F. C., (Ret.), Asst. Engr., Wabash, 416 Oak, Macon, Mo. 1922
Hutcheson, W. A., (Ret.), Supvr. Wk. Equip., C. & O., 620 Douglas St., Clifton Forge, Va. 1939
Hutchings, V. W., (Ret.), B. & B. Supvr., S. P., 3594 E. Central, Fresno, Calif. 1941

I

Inabinet, J. V. (Ret.), Gen. Brdg. Insp., S. A. L., 1142 Monterey St., Jacksonville, Fla. 1948

J

Jackman, H. E., (Ret.), Mast. Carp., B. & O., 570 Eastern Ave., Chillicothe, Ohio 1944
Jackson, T. E., (Ret.), Gen. B. & B. Supvr., S. P., 144 Sickles Ave., San Francisco, Calif. 1940
Johnson, B. O., (Ret.), Off. Engr., C. M. St. P. & P., 728 Avenida Feliz, Tucson, Ariz. 1931
Johnson, D. H., (Ret.), Supvr. B. & B., C. St. P. M. & O., 1342 Edgerton St., St. Paul 1, Minn. 1940
Johnson, R. W., (Ret.), Asst. Engr., C. M. St. P. & P., 1980 9th Ave., Yuma, Ariz. 1922
Jones, A. C., (Ret.), B. & B. Supv., Sou., Rt. 3, Box 1003, Birmingham 13, Ala. 1938

K

Kemmerer, W. G., (Ret.), Engr. B. & B., P. R. R., 508 Rockavon Rd., Narberth, Pa. 1931
Kvenberg, S. E., (Ret.), Supvr. Bldg. Maint., C. M. St. P. & P., 123 Stanton Point Rd., Ingleside, Ill. 1932

L

Lacher, W. S., (Ret.), Secy., A. R. E. A., 407 E. Fuller Rd., Hinsdale, Ill. 1922
Lampson, W., (Ret.), Supvr. B. & B., M. C, c/o D. G. Lowry, 477 Congress St., Portland, Me. 1930

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Lord, H. T., (Ret.), B. & B. Mast., C. P., 415 Third St., So., Kenora, Ont., Can. 1940

Luther, L. A., (Ret.), Serv. Engr., Ingersoll Rand Co., 1121 Hamilton Ave., Palo Alto, Calif. 1945

Mc

McDaniel, W. L., (Ret.), Vice Pres., American-Marietta, 701 Fairhope Ave., Fairhope, Ala. 1945

McKay, A. G., (Ret.), Supv. B. & B., N. Y. N. H. & H., 11 Pine Island Road, Jupiter Pt., Groton, Conn. 1915

McMahon, T. D., (Ret.), Arch., G. N., 223 Lake Avenue, White Bear Lake 10, Minn. .. 1918

M

Madson, H. C., (Ret.), Design., C. & N. W., 1327 Curtiss Ave., Ames, Iowa 1940

Manley, B. F., (Ret.), Supvr. B. & B., P. E., P.O. Box 197, Sunset Beach, Calif. 1916

Manning, D. A., (Ret.), Supv. B. & B., C. & N. W., 9120 Sherman Ave., Brookfield, Ill. 1939

Martens, W. F., (Ret.), Gen. Fore. B. & B., A. T. & S. F., 3396 Mayfield Ave., San Bernardino, Calif. 1924

Mateer, W. G. (Ret.), Mgr. Pur. & Stores, E. J. & E., 511 W. Jefferson St., Joliet, Ill. .. 1944

Mayfield, L., (Ret.), Prin. Asst. Engr., M. P., 4036 Gilbert Dr., Shreveport, La. 1944

Meeks, W. R., (Ret.), B. & B. Supvr. M,. P., 727 Eldon Dr., Lincoln 10, Nebr. 1942

Merwin, P. B., (Ret.), Asst. Engr., C. & N. W., 8951 S. E. Fuller Road, #7 Pierson's Mobile Club, Portland 66, Oreg. 1929

Moore, I. A., (Ret.), Ch. Engr., C. & E. I., 2321 N. Vermilion St., Danville, Ill. 1937

Mottier, C. H., (Ret.), Vice Pres., I. C., 135 East Eleventh Place, Chicago, Ill. 1942

N

Nies, A. B., (Ret.), Arch., N.Y.C. System, 408 Third St., Jackson, Mich. 1915

O

O'Brien, W. J., (Ret.), Dist. Carp., C.M.St.P. & P., Juneau County, Necedah, Wis. 1919

Oest, W. C., (Ret.), Prin. Asst. Engr., Ft. W. & D., 4633 Calmont, Ft. Worth, Texas 1947

P

Pahl, W. H., Jr., (Ret.), Asst. Supvr. Struct., P. R. R., 2211 Walshire Ave., Baltimore 14, Md. 1950

Parker, W. V., (Ret.), Gen. Fore. B. & B., St. L. S. W., R. R. #1, Box 122, Arlington, Tenn. 1911

Peterson, N. E., (Ret.), Ch. Engr., C. & I. M., Springfield, Mo. 1938

Pfeiffer, A., (Ret.), Asst. B. & B. Supvr., S. P., 58 Sandburg Dr., Sacramento 19, Calif. 1939

Phillips, W. J., (Ret.), Asst. Gen. Br. Insp., S. P., 318 Arlington Ave., Berkeley, Calif. .. 1925

Piccone, C., (Ret.), Br. Engr., Nat.Rys. of Mex., Monte Everest 210, Lomas de Chapultepec, Mexico City, Mex. 1923

Podas, N. F., (Ret), Ch. Engr., St. P. U. D. Co. & M. T. Ry. Co., 1238 Randolph Ave., St. Paul 5, Minn. 1937

R

Richards, C. A. J., (Ret.), Asst. Supv. Struc., P. R. R., 2717 Woodland Hills Ave., Lakeland, Fla. 1924

Rights, H. T., (Ret.), Asst. Br. Engr., L. V., 1015 Raymond Ave. Bethlehem, Pa. 1927

Rintoul, D. T., (Ret.), Gen. Br. Insp., S. P., 2571 Glen Green, Hollywood 28, Calif. .. 1910

Robinson, G. E., (Ret.), Asst. Ch. Engr., N. Y. C., 12 Hillwood Ave., Metuchen, N. J. 1948

Roof, W. R., (Ret.), Br. Engr., C. G. W., 7728 So. Yates Ave., Chicago 49, Ill. 1927

Rowland, O. F., (Ret.), Asst. Engr., D. & H., c/o Berkshire Industrial Farm, Canaan, N. Y. 1923

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Shobert, F., (Ret.), Sys. Steel Const. Fore., S. P., 419 Pope St., Menlo Park, Calif.	1918
Singer, E. W., (Ret.), Supv. B. & B., N. Y. C. & St. L., 6727 3rd Ave. North, St. Petersburg, Fla.	1923
Smith, C. E., (Ret.), Vice Pres., N.Y. N.H. & H., 282 Prospect St., New Haven, Conn.	1911

T

Taggart, C. R., (Ret.), Supv. B. & B., N. Y. C., 514 N. Drexel Ave., Indianapolis, Ind.	1935
Tattershall, E. R., (Ret.), Supv. of Maint. Equip., N.Y.C., 21 Clay St., Malone, N. Y.	1913
Thelander, P. V., (Ret.), Asst. Ch. Engr., C. & N. W., 809 N. E. Conway Blvd., Port Charlotte, Fla.	1939
Todd, D. C., (Ret.), Asst. Engr., P. R. R., Wilmington, Del.	1942
Tourtellotte, E. B., (Ret.), Asst. Div. Engr., B. & M., 61 James St., Greenfield, Mass.	1947
Truss, F. W., (Ret.), Mgr. R. R. Sls., Armco Drainage & Metal Prod., 701 Park St., Paris, Tenn.	1946
Tucker, N. R., (Ret.), Asst. Div. Engr., T. & N. O., Houston, Tex.	1939

V

Varker, J. L., (Ret.), Spec. Engr., D. & H., 21 Archbald St., Carbondale, Pa.	1936
von Sprecken, T. M. (Ret.), Asst. to Ch. Engr.-Sys., Sou., 3845 N. Chesterbrook Rd., Arlington 7, Va.	1938

W

Walden, W. H., (Ret.), Rdm., Southern, 1012 Porter St., Richmond 24, Va.	1920
Wall, E. G., (Ret.), Div. Engr., G. M. & O., Bloomington, Ill.	1942
Wang, A. B., (Ret.), Supvr. B. & B., Monon, 303 Murphy St., Lafayette, Ind.	1950
Whitehouse, B. M., (Ret.), Ch. Fire Insp., C. & N. W., 2008 Isabella St., Evanston, Ill.	1927
Wray, H. O., (Ret.), Secy. & Ch. Engr., T. C. T., 511 Bay Street, P. O. Box 1054, Texas City, Tex.	1939

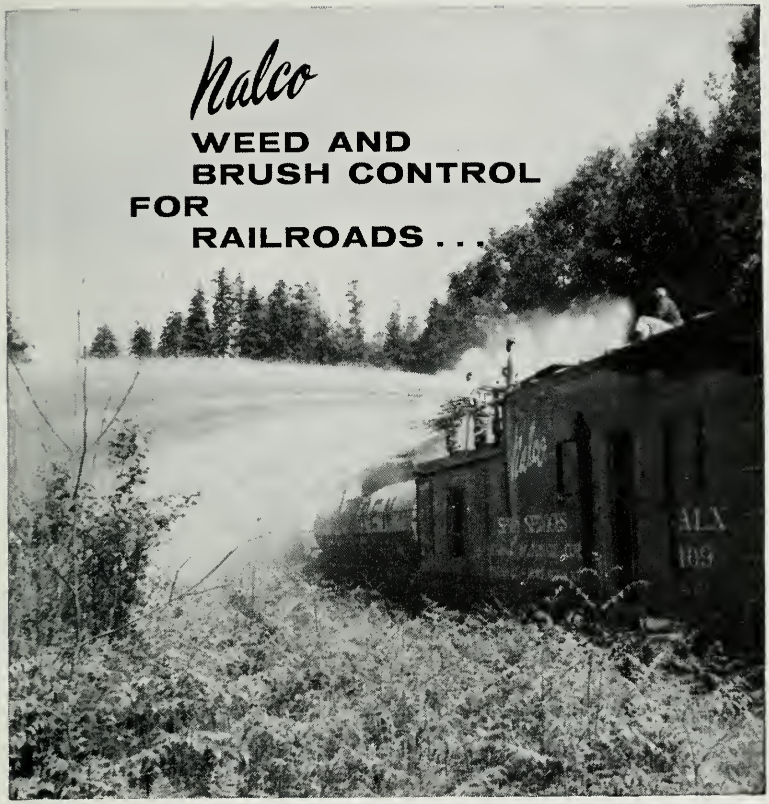
Y

Yewell, J. E., (Ret.), Ch. Engr., B. & L. E., 32 Second Ave., Greenville, Pa.	1941

ASSOCIATE MEMBERS

B

	Joined In
Barnes, C. E., Barnes Supply Co., 141 Eleventh St., San Francisco 3, Calif.	1964
Bell, C. R., Jr., Vice Pres., Quaker City R. R. Sls. Co., 3207 Kensington Ave., Philadelphia 34, Pa.	1960
Belton, C. W., Sls. Engr., Edward R. Bacon Co., 2101 Folsom St., San Francisco, Calif.	1964
Berkel, C. J., Berkel & Co. Contractors, Inc., P. O. Box 335, Bonner Springs, Kans.	1959
Bishop, D. B., Dist. Mgr., Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.	1946
Blackford, W. A., Sls. Engr., Pettibone Mulliken Corp., 593 Market St., Ste. 809, San Francisco, Calif.	1960
Boatright, D. D., Dist. R. R. Mgr., Chipman Chem. Co., Inc., 1125 15th Ave., N., Bessemer, Ala.	1962
Bredberg, R. E., Staff Engr., G. A. Heft & Co., 820 Union St., New Orleans, La.	1962



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Brown, S. C., Adv. Mgr., American Hoist & Derrick Co., 63 S. Robert St., St. Paul 7, Minn.	1960
Bugbee, W. E., Railway Equip. & Supplies, 1804 Alamo National Bldg., San Antonio, Texas	1956

C

Campbell, H. D., Sls. Mgr., Kershaw Mfg. Co., Inc., 2205 W. Fairview Ave., Montgomery, Ala.	1961
Cavins, K., Vice Pres., Fairmont Railway Motors, Inc., 332 S. Michigan Ave., Chicago, Ill.	1960
Caywood, J. A., Pres., Royce Kershaw Co., Inc., P.O. Drawer 1711, Montgomery 1, Ala.	1959
Clark J. G., Pres., Clark, Dietz, Painter & Assoc., Engrs., 211 N. Race Street, Urbana, Ill.	1963
Comp, R. O., Jr., Sls. Mgr., Buckeye Iron & Brass Works, P. O. Box 883, Dayton 1, Ohio	1960
Cone, D. P., Pres., American Concrete Crosstie Corp., Prestressed Concrete Crosstie Prod., P.O. Box 11476, Tampa, Fla.	1960
Corporon, F. J., Engr. Adm. National Account Sls., Motorola Comm. & Electronics, Inc., 4545 W. August Blvd., Chicago, Ill.	1950
Cox, E. W., Mgr. Ry. Sls., W. T. Cox Co., 580 Hiway 54 West, Camdenton, Mo.	1960
Creed, T. F., Jr., Res. Mgr., Sverdrup & Parcel and Assoc., Inc., Rm. 1509, Barnett Natl. Bank Bldg., Jacksonville, Fla.	1962
Crosby, R. C., President, Kershaw Mfg. Co., P.O. Box 1711, Montgomery, Ala.	1961
Cross, E. T., Vice Pres., Armco Steel Corp., 1001 Grove St., Middletown, Ohio	1946
Cummins, C. P., Br. Engr., St. L. Co. Div. of Hiways, Clayton, Mo.	1948

D

Davidson, T., Asst. Mgr., Globe Chemical Company, 80 E. Jackson Blvd., Chicago, Ill.	1955
Davis, V. W., Mgr. R. R. Sls., Metal Prod. Div., Armco Steel Corp., P. O. Box 1343, Atlanta, Ga.	1960
Denton, J. H., Sls. Engr., Southern Amiesite Asphalt Co., 3401 5th Ave., N., Birmingham, Ala.	1958
Detzel, G. E., Geo. E. Detzel Co., 1231 Draper St., Cincinnati 14, Ohio	1945
Deubel, H. R., Mgr. RR. Div., Chicago Pneumatic Tool Co., 936 E. 87th St., Chicago 19, Ill.	1956

E

Enstrom, W. A., Mgr. Trk. Mat'ls. Div., Pettibone Mulliken Corp., 4710 W. Division St., Chicago, Ill.	1956
Evans, R., R. R. Sls. Engr., Metal Prod. Div., Armco Steel Corp., 20 N. Wacker Dr., Chicago 6, Ill.	1959
Evinger, F. W., R. R. Rep., The Leon Co., 3243 Euclid Ave., Apt. #2A, Berwyn, Ill.	1946

F

Femberg, H. D., Pres., Oh-Zo-Dry Co., Inc., Tonganoxie, Kans.	1961
Flinn, L. E., Sls. Mgr. R. R., M. W. Div., J. W. Mortell Co., 550 N. Hobbie Ave., Kankakee, Ill.	1949

G

Giles, J. M., R R. Sls. Mgr., Caterpillar Tractor Co., Peoria 8, Ill.	1938
Griffin, B. A., Sls. Rep., Fabreeka Prod. Co., Inc., 8137 N. Ridgeway Ave., Skokie, Ill.	1963
Guest, W. H., Vice Pres.-Sls., MKT Corporation, 100 Richards Ave., Dover, N. J.	1962

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Haigh, S. H., Pres., Stan H. Haigh Co., 333 First Federal Bldg., St. Paul 1, Minn. 1961

Hansen, D. G., Ry. Sls. Mgr., Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis 14, Minn. 1962

Heald, J., Sls. Mgr., Nebraska Prestressed Concrete Co., 630 Cornhusker Highway, Lincoln, Nebr. 1962

Hickey, J. F., Pres., Baker & Hickey Co., P. O. Box 5008, Tri-Village Sta., Columbus 12, Ohio 1946

Hinn, R. L., West. Territory Mgr., Air Placement Equip. Co., P.O. Box 9601, Kansas City, Mo. 1964

Hoelzel, W. N., Mgr. R. R. Prod. Sls., Screw & Bolt Corp. of America, 122 S. Michigan Ave., Chicago 3, Ill. 1949

Hofer, P., East. Area Mgr., Pettibone Mulliken Corp., R. R. Mach. Div., 5720 Empire State Bldg., New York 1, N. Y. 1956

Holmes, J. L., Rep., Bird Tie Pads, Inc., 721 Second Ave., West Haven, Conn. 1956

Holstein, F. W., Pres., Fred W. Holstein Co., Hopatcong, N. J. 1948

Hopkins, W. S., Jr., Process Equip. Tech., Air Reduction Sales Co., 19352 Chicago Ave., Lansing, Ill. 1949

Howe, A. K., Staff Engr.-Tech. Serv., Sika Chemical Corp., 35 Gregory Ave., Passaic, N. J. 1962

J

Jackson, L. E., Sls. Mgr., Ken-Ray Brass Prod., Inc., Vermont, Ill. 1961

Johnson, I. K., Const. Supt., Linnan Const. & Engr., Inc., 3958 N. 54th St., Milwaukee 16, Wis. 1953

Johnson, S. C., Exec. Secy., (Ret.), Association Track & Structure Suppliers, 332 S. Michigan Ave., Chicago, Ill. 1960

Johnson, W. A., Reg. Engr., Armco Steel Corp., Metal Prod. Div. 925 Village Center, Lafayette, Calif. 1961

K

Kalousek, H. L., Pres., Air Placement Equip. Co., P.O. Box 9601, Kansas City, Mo. 1963

Kellogg, J., RR. Sls. Rep., National Lead Co., 111 Broadway, New York 6, N. Y. 1956

Kelly, R. J., Kelly System Inc., 422 N. Western Ave., Chicago, Ill. 1958

Kent, E. L., Jr., Sls. Engr., Coast Paint & Lacquer Co., P. O. Box 1113, Houston 1, Tex. 1962

Kleinkort, J. P., Prod. Mgr., American Brake Shoe Co., 155 N. Wacker Drive, Chicago, Ill. 1960

Klosk, L., Pres., Railroad Maintenance Corp., 1555 Grand Concourse, New York 52, N. Y. 1959

Krueger, T. W., Vice Pres. & Gen. Mgr., Duff-Norton Co., P. O. Box 1719, Charlotte 1, N. C. 1960

L

Lacey, J. W., Rep. R. R. Dept., Union Carbide Corp., Linde Div., 230 N. Michigan Ave., Chicago 4, Ill. 1946

Layer, J. P., Reg. Engr.-R. R., Armco Steel Corp., Metal Prod. Div., P. O. Box 170, Middletown, Ohio 1960

Lehmkuhl, E. J., Sls. Mgr., Arcair Co., P. O. Box 406, Lancaster, Ohio 1960

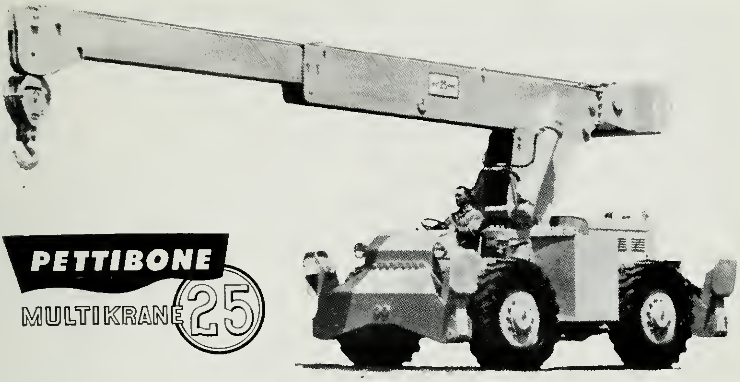
Leyh, G. F., Ry. Rep., Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill. 1963

Lipscomb, W. P., Reg. Engr., Armco Steel Corp., Metal Prod. Div., P. O. Box 1699, Houston, Tex. 1956

Lunde, A. C., Ry. Sls., Detroit Graphite Div., The Valspar Corp., 7701 W. 47th St., Lyons, Ill. 1959

Lynch, J. K., Secy.-Treas., Huntsville Concrete Pipe Co., Inc., 13209 S. Memorial Parkway, Huntsville, Ala. 1951

Lyon, C. A., Vice Pres., Empire Bldg., #10, Tango-cho, Akasaka Minato-ku, Tokyo, Japan 1945



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McDuff, L. H., Secy.-Treas., W. R. Fairchilds Construction Co., Ltd., P. O. Box 31, Hattiesburg, Miss. 1963
McGough, J. P., Salesman, Fabreeka Prod. Co., Inc., 8137 N. Ridgeway Ave., Skokie, Ill. 1963
McMahon, R. D., Div. Mgr., Fabreeka Prod. Co., Inc., 15 St. Albans Circle, Newton Square, Pa. 1955

M

Mabry, D. B., Mgr. Lumb. Sls., T. J. Moss Tie Co., 700 Security Bldg., St. Louis, Mo. 1948
Mains, W. W., Area Mgr.-West. Area, Armco Steel Corp., Metal Prod. Div., 130 East 5th Ave., Denver, Colo. 1960
Mann, E. A., Vice Pres., Modern Supply Co., 222 W. Adams St., Chicago 6, Ill. 1951
Mann, R. E., Pres., Modern Supply Co., 222 W. Adams St., Chicago 6, Ill. 1961
Miller, R. H., Oper. Mgr., Matisa Railweld, Inc., 1020 Washington, Chicago Heights, Ill. 1953

N

Needham, L. H., Chair. of Board, The Penetryn System, Inc., 38399 Pelton Road, Willoughby, Ohio 1946
Nicholson, L. P., Field Engr., Portland Cement Association, 816 West Fifth St., Los Angeles 17, Calif. 1958

P

Patterson, R., Const. Consult., 80 E. Jackson Blvd., Chicago 4, Ill. 1946
Patton, R. C., Roy C. Patton Co., 3416 Silver Palm Rd., Jacksonville Beach, Fla. 1952
Pearson, W. C., Mgr. R. R. Div., U. S. Welders Supply Co., 2328 W. Toughy Ave., Chicago, Ill. 1964
Pepple, R. L., Reg. Engr. R. R., Armco Steel Corp., Metal Prod. Div., 3420 Van Buren, Topeka, Kans. 1961
Petteys, W. F., R. R. Consult., 501 Mandalay, Apt. F-5, Yacht Basin Apts., Clearwater Beach, Fla. 1948
Phillips, R. O., Mgr. Tech. Serv., Research & Development Associates, 909 N. Main. St. Ft. Worth, Texas 1961
Piepmeier, A. L., Vice Pres., Turner Engineering Co., 112 Union St., Nashville 3, Tenn. 1953
Polk, P. W., Vice Pres. & Gen. Mgr., Buckeye Iron & Brass Works, P. O. Box 883, Dayton 1, Ohio 1960

R

Reilly, W. C., Vice Pres., Conley Frog & Switch Co., P.O. Box 9188, Memphis, Tenn. 1960
Robinson, J. C., Reg. Engr. R. R., Armco Steel Corp., Metal Prod. Div., P. O. Box 2170, Denver, Colo. 1962
Roof, W. B., Const. Engr. & Asst. to R. R. Sls. Vice Pres., Metal Prod. Div., Armco Steel Corp., Curtis St., Middletown, Ohio 1958

S

Scroggs, J. E., Pres., Railway Techniques, Inc., 3316 Broadway, Kansas City, Mo. 1958
Seppa, K. E., Sls. Engr., Armco Steel Corp., Metal Prod. Div., 220 W. Harrison, Seattle, Wash. 1960
Smith, C. E., Dist. Sls. Mgr., American Brake Shoe Co., P. O. Box 7353, Houston 8, Tex. 1960
Standish, J. H., Sls. Rep., American Brake Shoe, R. R. Prod. Div., P. O. Box 7353, Houston, Texas 1961
Storer, J. W., Vice Pres., Osmose Wood Preserving Co., 4505 Monona Drive, Madison, Wis. 1961

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Thomas, J. M., Sls. Engr., Armco Steel Corp., Metal Prod. Div., P.O. Box 4765, Portland, Oreg. 1960

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Van Landenham, J. C., Sls. Engr., Roy C. Patton Co., Jacksonville Beach, Fla. 1964

W

Warrenfells, J. F., So. Sls. Mgr., Weir Kilby Corp., Taylor-Wharton Co., Birmingham, Ala. 1946
White, H. L., Ch. Sls. Engr., Armco Steel Corp., Metal Prod Div., 1001 Grove St., Middletown, Ohio 1962
Williams, C. B., Pres., Ever Tight Bolt Assembly Co., 238 Lincoln Ave., Council Bluffs, Ia. 1954
Williams, G. S., Supt., Southern Amiesite Asphalt Co., Inc., 3401 5th Ave. No., Birmingham, Ala. 1956
Williams, W. L., Sls. Devel. Engr., Enjoy Chemical Co. Div. Humble Oil & Refining Co., 60 W. 49th St., New York, N. Y. 1964
Williamson, W. M., Res. Rep., Fairmont Railway Motors, Inc., 2208 Riverside Drive, Houston 4, Tex. 1960
Wilson, W. C., Pres., Southeastern Ry. Supply, Inc., P. O. Box 368, Arlington 10, Va. . . 1951
Wingerson, C., Ry Sls. Engr., Screw & Bolt Corp. of America, P. O. Box 1708, Pittsburgh 30, Pa. 1954

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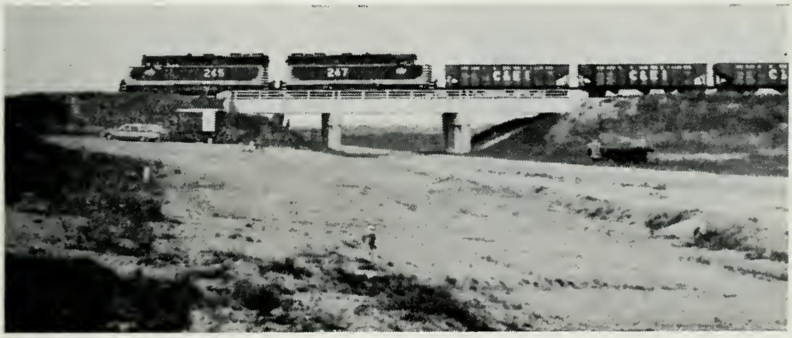

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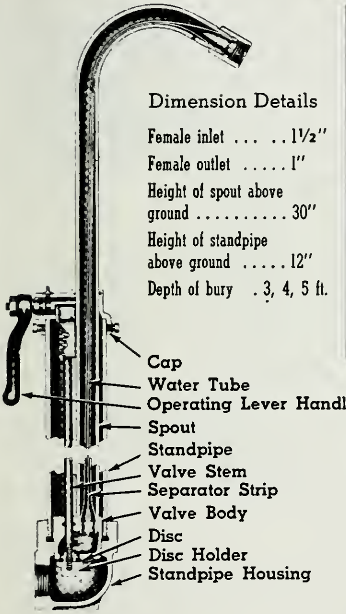

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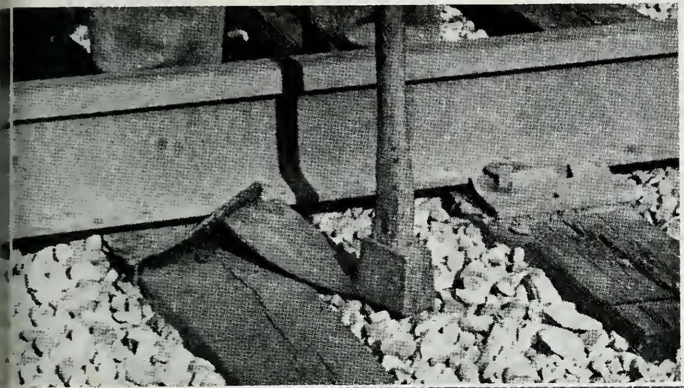

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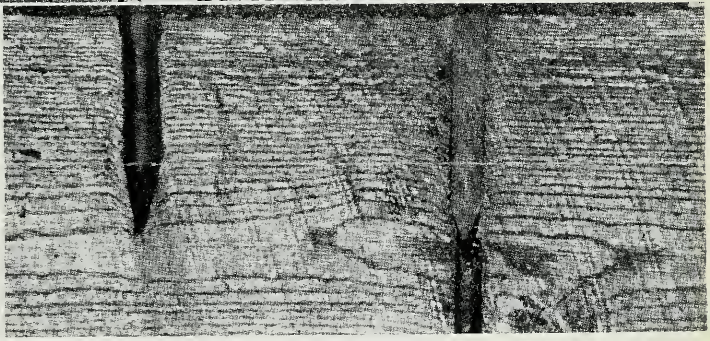

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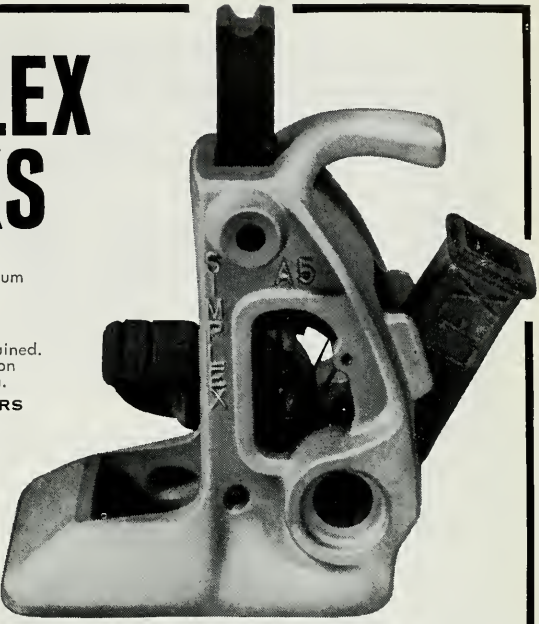

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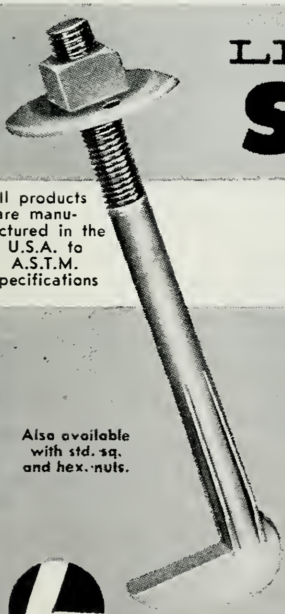

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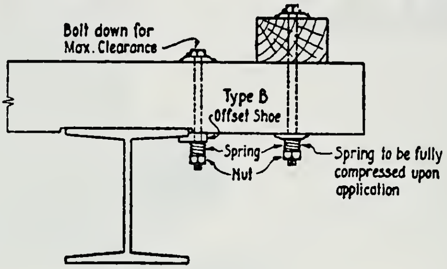
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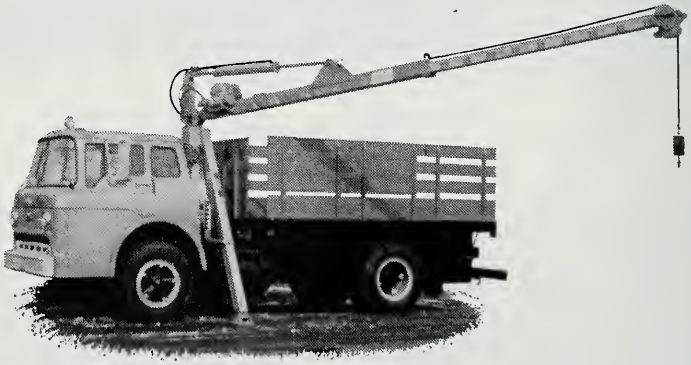

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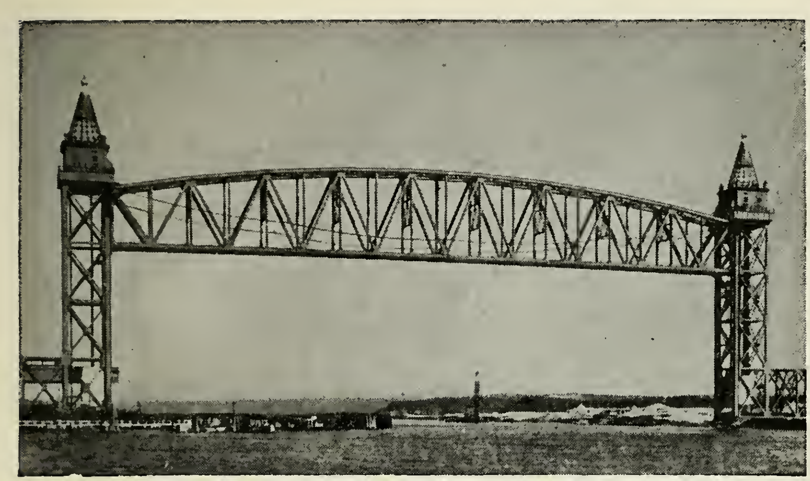

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